WORLD PETROLEUM

JULY 15, 1959

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TWENTY-NINTH ANNUAL REFINERY REVIEW

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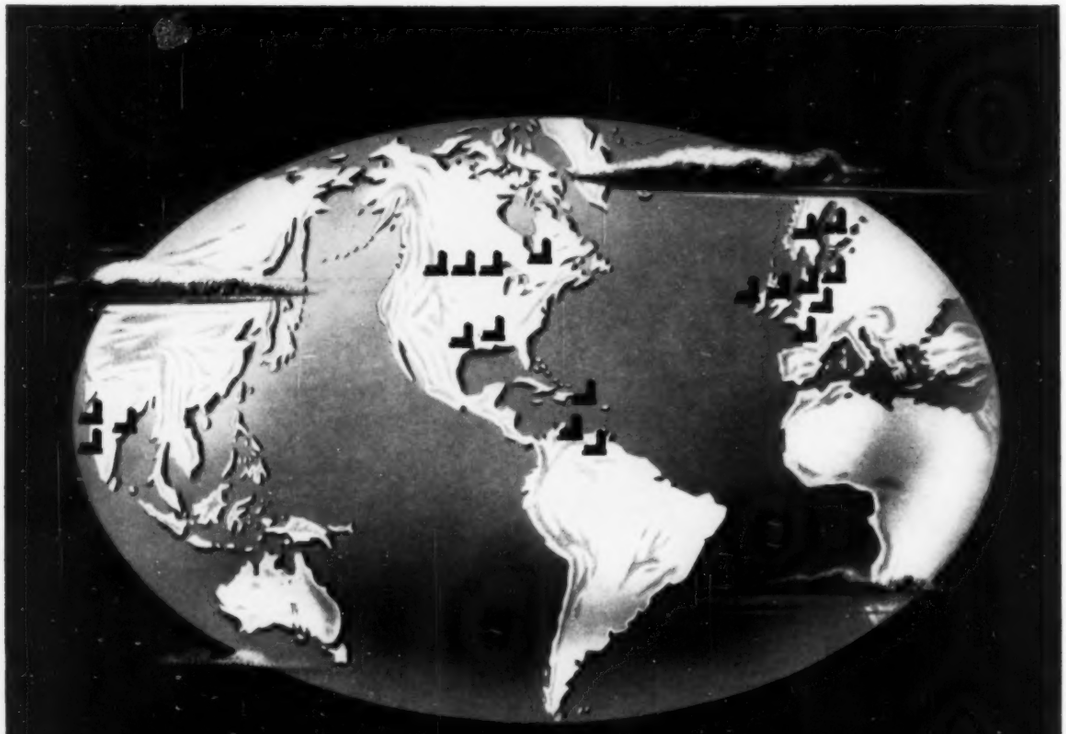

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THIS MONTH'S COVER

Powerformer at the Everett, Massachusetts, refinery of Esso Standard Oil Co. Color plates courtesy Badger Manufacturing Co., builder of the reforming unit.

Washington PIPE LINE

by Joseph B. Huttlinger

Refinery Construction Up 8%

The American petroleum refining industry plans to spend $2,621 million on new plant and equipment during 1959, according to latest reports to the Department of Commerce and the Securities and Exchange Commission.

This is a gain of eight percent over the total of $2,431 million in 1958. Tre total is lower than the figures of $3,453 million in 1957 and $3,135 million in 1956, the report said.

The petroleum refining industry spending now is estimated at a lower figure than once reported by petroleum companies to government officials. Earlier reports had estimated spending of about $2,747 million, a gain of 13% over 1958 levels.

A hefty fourth quarter spending of $815 million is foreseen in the report from the government agencies. The spending by quarters is estimated as follows:

First quarter, 1959	$518 million
Second quarter, 1959	631 million
Third quarter, 1959	657 million
Fourth quarter, 1959	815 million
Total	$2,621 million

Rules On Import Controls

The Oil Import Appeals Board continues to hold a tight rein on itself, as it considers about 70 appeals for higher quotas under the oil-import program. In more than 30 decisions, the board has given less than 10,000 b d of extra quota to import oil, none of it for finished products. Apparently, the board is retreating behind its regulations in any case in which it can find it lacks the authority to grant relief. This is significant, as some boards have tried to stretch their authority.

Rulings of the board make clear these things: (1) It will give no relief for appeals attacking the basis of the oil-import program, itself. Thus, it summarily dismissed appeals of several major oil companies challenging the sliding scale of quotas to refinery inputs, handing out quotas to a parent company rather than a subsidiary. (2) It will hold the line on product imports, giving no quotas to persons who ordered before the program began but got delivery later, who face competition from others using imported residual or other products, or who claim their products are "special" cases. The board has only limited authority over product quotas. (3) The board will take account of a company's history of crude-oil imports to grant relief. Thus, it gave some relief to Gabriel Oil Co., Houston, which has no refinery, and thus does not qualify for a crude-oil import quota because it had been an importer in the past. (4) It will not allow higher import quotas as a credit against products exported from the imported crude. The board feels, if the program contemplated this kind of credit, it would have specified it. (5) The board will consider specific, proven, "exceptional" hardships, such as a fire which shut down a refinery, to give larger crude-oil import quotas. But the board does not regard a strike as an "exceptional" hardship.

What's An Import Quota Worth?

What's the value of a quota to import crude oil and unfinished oils? Crown Central Petroleum Corp. calculates it is 63.74 cents a barrel for crude and 32.33 cents a barrel for unfinished oils. This works out to a composite figure of 57.26 cents a barrel for both crude and unfinished oils, it says. Crown Central told the Oil Import Appeals Board this is the difference between the costs to it of imported oil and costs of domestic oil.

In a statement prepared by Ernst and Ernst, accounting firm, and submitted to the board, Crown Central said this indicates it needs a larger quota to be competitive with others who market on the USA East Coast. P.S.: The board said no.

Study World Line Pipe Demand

Stanford Research Institute, Menlo Park, Calif., is doing a study of past, present, and future world demand for large-diameter line pipe. The Study concentrates on pipe of 16-in. diameter and larger. Natural gas, crude-oil, and oil-products pipe demand is being covered.

John M. Huneke, industrial economist of the institute, is in charge of the study. As a first step, he sent off a query to USA consular offices around the world late in April. He asked for a list of oil and gas pipelines completed, their starting and ending points, length, diameter, and what products they carry, as well as the wall thickness, the owner, date of start and end of construction, and source of the pipe. He asked roughly the same information with regard to proposed pipelines. He also seeks facts as to any pipe mills in the various countries.

Rejects Export Licenses

Secretary of Commerce Lewis Strauss said that 12,227 short tons of line pipe of 28-in. and 30-in. diameter is not the only commodity he refused to license for export to Soviet Russia and her satellites during the first quarter of this year. In the latest quarterly export control report, he said the main rejection was of an application to export to Russia $10,361,714 worth of polyethylene.

He also refused a license to export $1,850,000 worth of stainless-steel sheets and plates to Russia; a license to export $33,815 worth of rotary drill rig parts to Hungary.

Strauss said he approved licenses to export $566,596 worth of electrical steel sheets to Poland, $55,018 worth to Czechoslovakia; $43,345 worth to Hungary.

Of the turndown of line pipe to Russia, the report said the application was disapproved for the third time in over a year, and involved a shipment with a value of about $2.5 million. "The turndown, following consideration of advice received from the interdepartmental committee, was made on the grounds that approval of the application would not be in the national interest," the report said.

"The department pointed out that line pipe of over 24-in. outside diameter is on the USA positive list of items requiring an individually validated export license for shipment to all destinations, including the Soviet bloc, outside the Western Hemisphere. There is a general presumption for denial of applications for license to ship positive-list items to the Soviet bloc.

"Line pipe is marketed in different grades with varying wall thicknesses. Given the total weight and possible sizes of pipe, the length which could be laid would range from about 30 miles for the heaviest grade to about 46 miles for the lightest grade.

"In this connection, it should be noted that the Soviet seven-year plan calls for many thousands of miles of pipeline. The pipe specified in the application meets API standards and is of the highest quality. It could be used for the transportation of crude oil, petroleum products, or gas.

"Recent reports from overseas have stated that the USSR is purchasing 24-in.-diameter line pipe from the Federal Republic of Germany. Line pipe of this diameter or less is not on the USA positive list.

"Previous Commerce action of denial of the license applications for the 28-in. to 30-in. pipe had been taken in accordance with established policies."

What Price Oil Imports?

Rear Admiral O. P. Lattu, executive director of the Military Petroleum Supply Agency, was asked by a House Government Operations subcommittee to submit a statement on the possible increased cost to the US government as a result of the import program. Under the oil-imports program, MPSA is in the same position as any other importer of oil products, limited to what it imported in 1957. MPSA has chafed at this, preferring a free hand to buy wherever it can get the best price. So, oil men will watch with interest to see if Mr. Lattu criticizes the imports program.

Mr. Lattu outlined the operations of his agency. He said that, if the imports program brings higher oil prices, he would so report to the Secretary of the Navy. He said if prices "should firm up in the US, and buying overseas were cut in half, it could cost the government more money."

Mr. Lattu said there is extensive competition within the oil industry. He explained that at times as many as 100 oil companies bid to supply products to MPSA and that their prices cover a spread of two cents or more "which adds up to a lot of money" on a million gallons. Even one-eighth of a cent is a lot of money, he said. USA officials are urging the construction of more pipelines.

Urge More Tanker Construction

USA officials are urging the construction of more tankers, despite the present surplus of tanker capacity. Prime need, they say, is replacement of "obsolete" vessels with newer ones. They say defense plans indicate "a vital need" of more tankers, and that 80% of the present USA tanker fleet will be over-age within five to 10 years.

Meanwhile, the USA merchant fleet had 276

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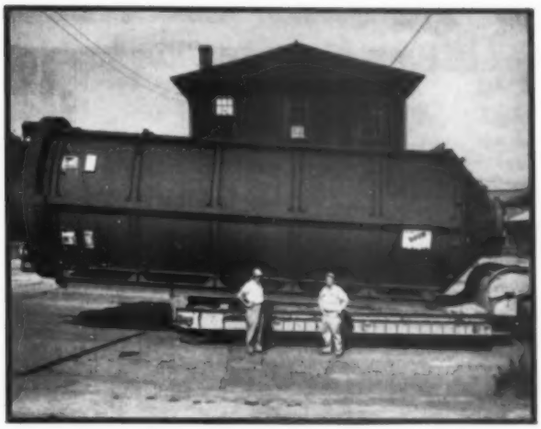

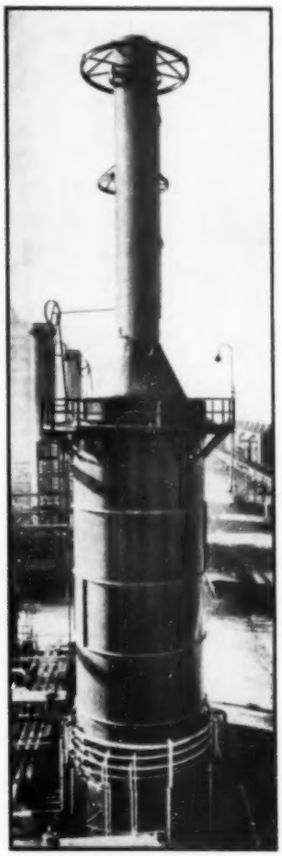

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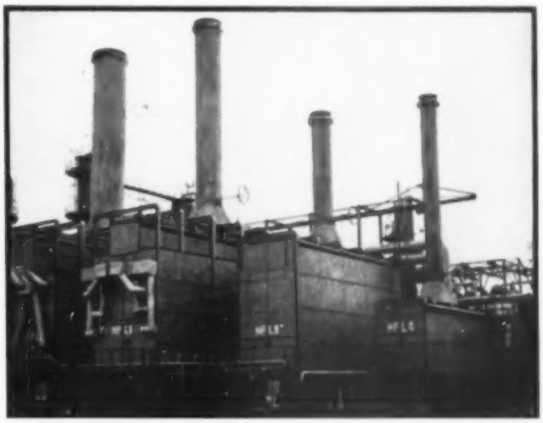

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(Continued from page 4)

tankers of 1,000 gross tons or more in May, all of them privately owned. Another 60 privately-owned tankers and 68 government-owned vessels were in the inactive fleet. Forty-eight of the tankers were laid up for lack of employment while the others were undergoing repair or conversion. Another 34 new large tankers were on order in private USA shipyards for private firms and one for the government. Four more were under contract for conversion in USA yards.

More Depletion Outside USA

The Eisenhower administration wants more, not less, income-tax incentives for USA firms operating abroad. While the chances are against passage of any legislation giving more tax incentives to firms to go overseas, the administration views will carry weight when senators try to cut down the depletion allowance for USA oil firms operating overseas.

Oil companies can argue that the administration itself says more spurs to foreign investment are needed, in complete disagreement with Senate backers of a cut on foreign depletion.

The US Treasury Department, usually out to find extra tax revenues, is opposed to a cut in foreign depletion on the grounds it would add little to revenues to the USA. Any cut in the USA depletion tax, thus saving money for foreign oil operators, would be absorbed by the foreign governments, it feels.

FPC Vs. Gas

The major effort of the Federal Power Commission to find a way to regulate prices of natural gas sold by independent producers is still a long way from final settlement. Although an FPC examiner issued his ruling, April 13, in the case of the Phillips Petroleum Co., parties to the case were given until June 26 to file their exceptions with the full commission. Many of the oil and gas producers involved asked this be the deadline, 60 days longer than the usual 20-day period. After that, the commission itself will want to study the huge volume of documents expected to be filed, in addition to the examiner's report of more than 300 pages of details, facts, and opinion. Finally, the commission will set a date for oral argument in the case, but it is doubtful whether this will be before the usual summer slowdown in August. After that, the commission will hand down its opinion, probably next year. That merely will clear the way for one party or another to appeal to the Circuit Court of Appeals in the case and, finally, to the US Supreme Court. It could be 1961 before the case reaches the Supreme Court.

The significance of the examiner's report is that it is the first which deals with all the factors involved in regulating rates of an independent producer of gas. The examiner recommended: (1) a cost-plus public-utility type of control; (2) a return on investment of 9.25%; (3) no credit to a producer for the statutory depletion allowance or intangible drilling costs, but only allowance of actual taxes paid; (4) costs of exploration divided between oil and gas operations on the basis of dollar value of reserves added during the latest five-year period; (5) costs of production from joint oil and gas wells divided on the basis of relative costs of producing oil from 100% oil wells and 100% gas wells; (6) rates to be set on the basis of the entire Phillips operation rather than a field-by-field basis.

While one theory is that the system which is adopted for Phillips will be used for all independent producers, there is another that small producers may yet escape direct regulation of their prices. Some economists explain that, if the Phillips rule were applied generally, it would result in rates as low as two cents per 1,000 cu ft and as high as 50 cents. So, this school goes, the commission may adopt a "pragmatic" rule, such as exempting small producers, using fair field prices, or an industry-wide or area-wide cost-of-service basis.

FPC Chairman Kuykendall said examiner's report in the Phillips case is "a surprise and disappointment to those vigorous proponents of the original cost-rate-base type of regulation." Many in this group, he explained, felt the regulation would bring "sharply reduced rates of large gas producers." The examiner recommended an average rate of 11.662 for all Phillips gas—an increase, not a decrease, from the present levels.

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LONDON LETTER

By Cecil W. Wood

Gas Reforming At Romford

At the recent inauguration of the gas reforming plant at the Romford works of the North Thomas Gas Board, Lord Mills, Minister of Power, said that the first trial cargo in the "Methane Pioneer" of 2,000 tons of liquefied methane had passed through the plant. Gas is also being received from Shell Haven and Coryton (Mobil Oil) refineries.

Romford was previously producing 5 mmcf/d of coal gas but now, with the new Onia-Gegi reforming and oil gasification plant, it is capable of 50 mmcf of 500 Btu sulfur-free gas a day in every way interchangeable with town gas from traditional methods.

Each of the four units of the reforming plant, built by Humphreys & Glasgow Ltd., were considered originally as likely to yield some 9 mmcf/d but there were hopes of higher output and provision was accordingly made for overload. Actually, the minister revealed, unit daily outputs of 12 mm were common and already 36 mm have been produced with three out of the four units in operation.

From another source—replies to questions in parliament—comes the official statement of the Ministry of Power that gas is now being made more cheaply from oil than from coal. The average cost is roughly 1s. 2d. per therm from oil against 1s. 4d. from coal.

It was also revealed that the gas industry's share of expenditure to date on research and experimental work with the production of town gas from liquefied methane was £1,500,000. This had been spent mainly on the tanker and for the onshore installations in Britain.

Royal Dutch/Shell Spending In The UK

The Royal Dutch Shell group placed orders with British industry worth £39 million last year, some £11 million less than in 1957. This excludes the very large expenditure on tanker construction, repair and victualling, and also on certain purchases for the group's chemical side. Compared with 1957, purchases for export declined from £38 million to £26,500,000 but, on the other hand, purchases for UK refineries and research establishments rose £500,000 to £12.5 mm in 1958. The group's actual shipments to overseas destinations in 1958, valued at £30 mm., are estimated to represent about 1% by value of total UK exports.

Multi-Grade Gas Pumps In Germany

BP's associated company in Germany has introduced multi-grade gasoline pumps at its service stations. The motorist can choose between blends containing 22, 50 or 75% premium fuel and the pump automatically delivers the desired mixture. BP is the first oil company to use a mixer pump outside Canada and the U.S.

New Zealand's First Refinery

Shell is to build New Zealand's first refinery, a 2 million ton year plant estimated to cost £17 million, and a survey to determine the best site is now being made. A new refinery company will be formed and New Zealand investors will have an opportunity to subscribe part of the capital.

Planning must consider unusual problems. Domestic product demand is complicated by unusually high gasoline consumption and the country's geographical position militates against economic export of surplus products. Processing must also be capable of handling a wide variety of crudes, including any indigenous source that may be found from the current search in which Shell is participating.

Largest Gotaverken Diesel

A 12-cylinder turbocharged marine diesel of Gotaverken design developing 15,000 bhp at 112 rpm has recently been delivered from the Uddevallavarvet engine shop in Sweden, and is now being installed in a 34,000 dwt tanker. It is believed that previously only two marine diesels of so high an output have been built. Having 760 millimeter bore and 1,500 millimeter stroke, this new Swedish engine with its 12 cylinders is the largest Gotaverken engine so far built.

World Production In 1958

Total world production of petroleum (including natural gasoline) in 1958, based on Petroleum Information Bureau (London) estimates in metric tons and reliable conversion factors, can be put at 6,916.6 million barrels, an increase of 171.6 million (2.5%) over 1957. In the free world the rise was entirely due to Eastern Hemisphere production. But whereas the free world share only 54.0 million barrels (0.9%) to 5,983.9 million, production in the Soviet bloc is estimated to have gone up 120.7 million barrels (18.4%) to 935.8 million. Based on individual country details, area production in the last two years can be summed up thus:

	1958		1957	
	Mill. Bbl.	%	Mill Bbl.	%
W. Hemisphere				
North America	2,903.1	42.0	3,098.6	46.0
Latin America	1,230.0	17.7	1,263.5	18.7
Total	4,133.7	59.7	4,362.1	64.7
E. Hemisphere				
Middle East	1,581.4	22.8	1,310.5	19.4
Far East				
Australasia	171.6	2.5	169.5	2.5
Europe	87.4	1.3	84.7	1.3
Africa	10.4	0.2	3.1	—
Total	1,850.8	26.8	1,567.8	23.2
Total Free World	5,983.9	86.5	5,929.9	87.9
Soviet bloc				
USSR	825.2	11.9	712.5	10.6
Others	110.6	1.6	102.6	1.5
Total	935.8	13.5	815.1	12.1
Total World	6,919.6	100.0	6,745.0	100.0

British Tanker Building

At March 31, 1959, according to Lloyd's Register, 72 oil tankers (100 tons gross and upwards) of 1,091, 791 tons were under construction in British yards. This is 27,596 tons more than at December 31 and represents 48.5% of the total tonnage of all ships building in the UK. The British total—of which all except 85,050 tons are for registration in the UK—also represents 20.9% of the world total of tanker building, 5226,548 tons, and the US total of 613,313 tons represents 11.7%.

More Methane Gas Extraction

The National Coal Board, which recently announced the ending of its experimental program of underground coal gasification, is to step up its program of methane gas extraction from deep mines. It will increase the present 62 drainage pits to about 87 over the next 3 years. This decision is stated to be the result of important technical advances. The current program is draining about 104 million cu ft a week, of which some 42 million are utilized. Under the new plan, over 200 million cu ft would be extracted and over 150 million used.

Unique Fire-Float

A unique self-propelled fire-fighting float designed by BP Tanker Co. is now in use in Swansea Harbor. Its main features are two 60-ft long and 40-ft wide pontoons, spaced 8 ft apart and joined at deck level and at their base by elliptical tubes to form a "catamaran." Four tubular supports surmount the pontoons to form a tower on which there are two platforms and, above the higher of these, a control cabin for the fire-master. Platforms and cabin top are fitted with nine 9-in. fire-fighting nozzles for water or foam, and so arranged that seven can be used in any one direction at once. The two diesel units are mounted centrally between the two pontoons, one at each end, and the propellers can be used as rudders or for maintaining the vessel in position against the force of the water jets.

Increased Fuel Oil Storage

Although only opened last September and then claimed as the largest of its kind in Britain, the Poplar fuel oil terminal of Charrington, Gardner, Locket & Co. Ltd., is to be expanded from 4,160,000 to 8,750,000 gallons at a cost of £120,000. Whessoe Ltd. are the main contractors and the extensions are expected to be completed by September. This central riverside position is stated to have greatly simplified fuel oil distribution to the London area and to have reduced operating costs.

Bitumen In Paper Bags

Multi-wall paper bags are now being used in Shell refineries to deliver bitumens previously sent in the traditional 35-gal drums as well as to customers without facilities for receiving hot bitumen or who prefer to receive it in small packages. The bags are made up of four layers of paper, the inside layer being specially treated to prevent adhesion to the bitumen and the outer for water resistance. By this means the customer now gets and easily handles 112-lb lots.

New Appointments

Following the construction of a new £1 million ocean-fed terminal at Ellesmere Port, Mobil Oil has announced the appointment of H. A. Rich (manager of the North Midland Retail Division) as division manager of the newly-created North Western Retail Division, and C. B. Cotterell (district manager in the Southern Retail Division) as division manager of the Northern Retail Division. These appointments and the creation of the new division reflect the expansion of the company's marketing in the north of England which this new terminal will permit. Another new appointment is that of G. S. Orr (district manager at Newcastle in the Northern Retail Division) as manager of the Scottish Division.

W. F. Tuson, formerly finance manager of Shell Chemical Co., has been appointed finance coordinator of the newly-formed Shell International Chemical Co. Ltd., and is succeeded by E. E. Bullen, MBE—an honor he received in 1942 for his service with the underground movement in Morocco, where he had served as Shell's chief accountant from 1931 to 1941. After working in West Africa from 1942 to 1946, Mr. Bullen has been in Shell International's finance administration, where his posts have included head of the methods department and controller—chemical industry.

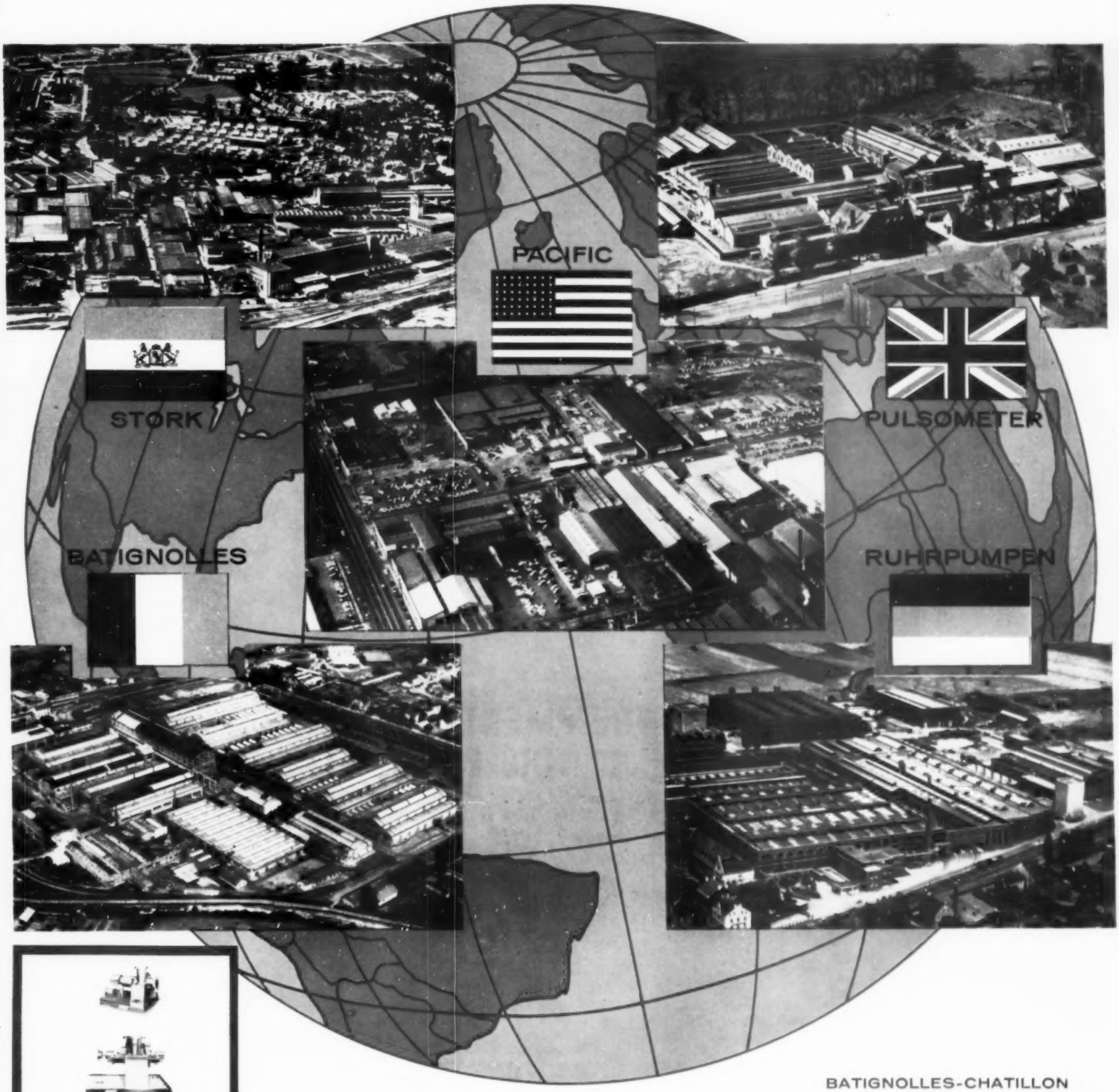
James Sutherland, formerly sales manager of Esso Petroleum Co.'s Scottish division, has been appointed divisional manager on the retirement of I. G. Brackenridge. He has been with the company since 1938 and has held various sales and managerial positions in Birmingham and Glasgow. Mr. Sutherland has just returned from an extended visit to the U.S., during which time he studied marketing methods and attended the business administration course of Pittsburgh University.

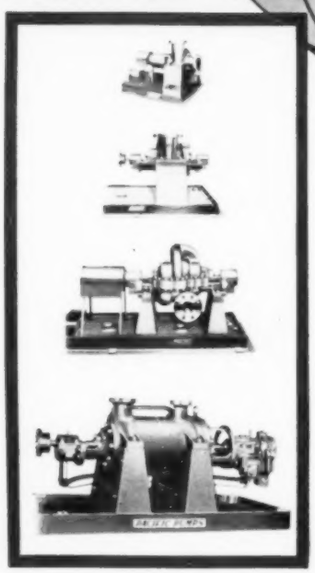
H. A. Rich

C. B. Cotterell

G. S. Orr

Pacific Pumps offers WORLD-WIDE Manufacturing





Pacific pumps designed specifically for use in petroleum refineries, petrochemical and other processing plants throughout the world are universally recognized for superior performance . . . long service life . . . trouble-free operation . . . low maintenance costs. Whether these pumps are built in Pacific's American plant or by one of the carefully selected foreign manufacturers—identical integrity of design, engineering, workmanship, materials and service is assured. Through these world-wide facilities, centrifugal pumps of Pacific design may be purchased in Sterling, Francs, Guilders, Marks, Dollars or other foreign currencies. We encourage your inquiries.

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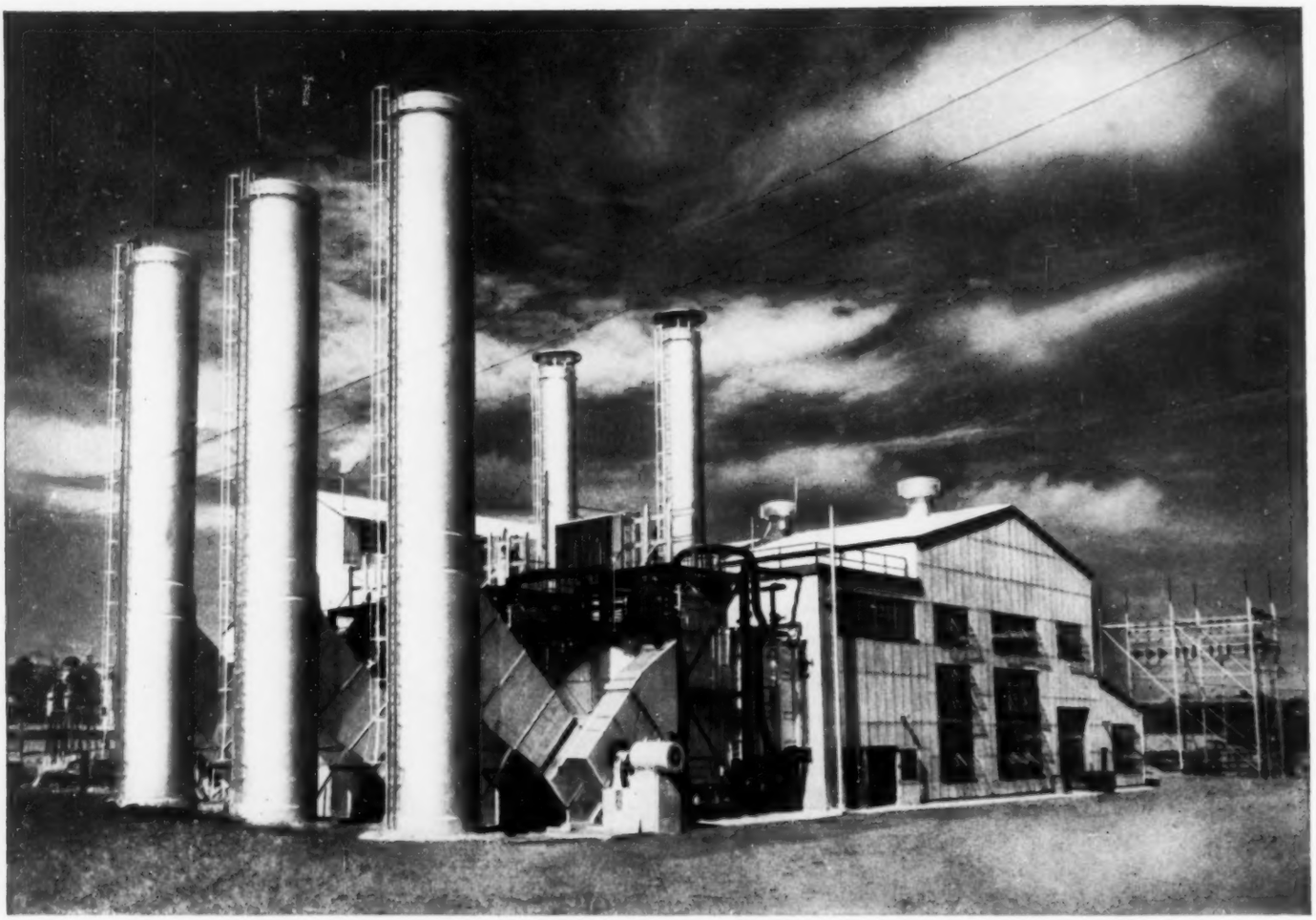
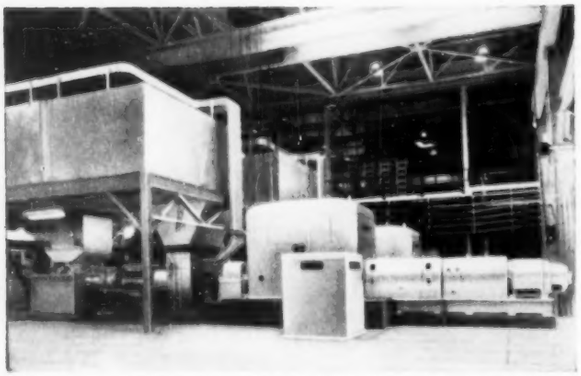


GENERAL ELECTRIC EQUIPMENT HELPS MODERNIZE COLOMBIA'S EL CENTRO POWER PLANT



5,000 kw General Electric gas turbines are natural gas-fired, single-shaft, simple-cycle units which exhaust into supplementary-fired waste-heat boilers.

New G-E Gas Turbines, Waste-Heat Boilers Increase Electrical Power and Process-Steam

One hundred and sixty miles north of Bogota, Colombia, Empresa Colombiana de Petroleos' El Centro Power Plant supplies power and process steam for oilwell pumping and the gasoline plant at their El Centro field in the State of Santander. Recently, company officials decided to replace some of the plant's 30 year old equipment in order to raise the output of both electrical power and process steam.

Included in the modernization equipment were two new General Electric 5-mw gas turbines, two supplementary-fired waste-heat boilers—all supplied by G.E. Still operating with this new equipment is a G.E. 5-mw steam turbine that was installed in 1930. These added facilities at El Centro will help increase Colombia's production of much needed petroleum, gasoline and liquified petroleum gas, and help increase the net dollar earnings for Colombia.

Dependable General Electric equipment has aided in the modernization of many plants throughout the world. For information on how G.E. can help you with your own modernization program, consult your nearest General Electric representative today, or write: *International General Electric Company, Dept. 59-39, 150 East 42nd Street, New York 17, N.Y., U.S.A.*

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With the advent of high compression ratio engines, usually starting at 9.5:1, motor fuel, especially those deficient in isoparaffins, have been associated with an unusual engine noise called "rumble." Further study reveals this rumble can be eliminated through the use of a better balanced fuel, namely using a fuel composed of a greater volume percentage of isoparaffins. Alkylation produces a high octane isoparaffin that also has good sensitivity, ignition point and combustion characteristics.

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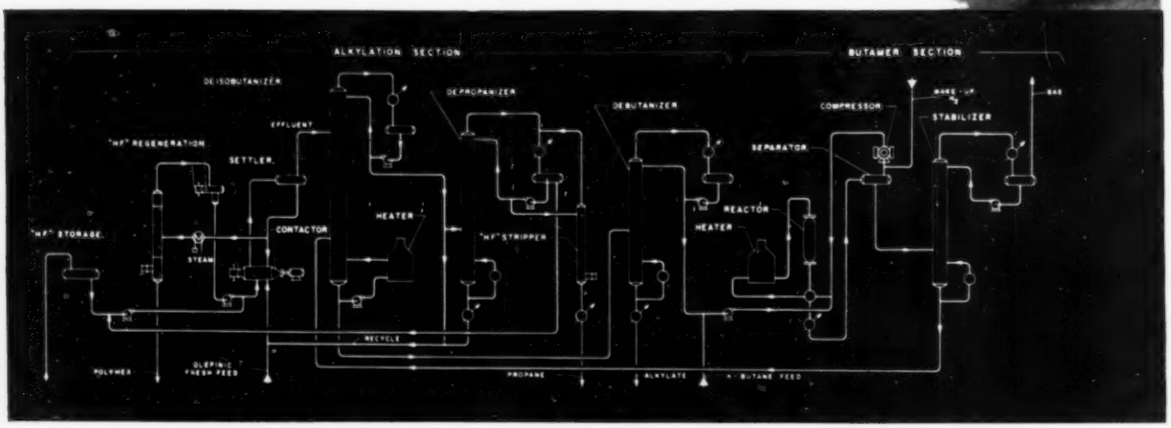

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HF Alkylation

Butamer—Heart of this process is a noncorrosive, stable and rugged platinum-containing catalyst especially developed by UOP. Capable of operating at relatively low temperatures, its use assures a sufficiently high concentration of isobutane in the reactor effluent to eliminate excessive recycle of normal butane.

Operating under hydrogen pressure, with low hydrogen-to-charge ratio, the high catalyst activity results in economical liquid hourly space velocities, thus requiring only a modest catalyst inventory. The mild operating conditions further assure minimum loss to by-products.

HF Alkylation—"HF" Alkylation is a catalytic process which combines olefins such as propylene, butylenes, and amylenes with isoparaffins (usually isobutane) to form a mixture of branched chain hydrocarbons of higher molecular weight known as alkylate for aviation and motor fuel.

These two processes are readily and economically integrated. Together, they form the ideal, most practical method for producing alkylate.

Write for detailed information. Ask also about other UOP refining and petrochemical processes, available to refiners everywhere, for improving operating efficiency and producing better and more profitable petroleum products.

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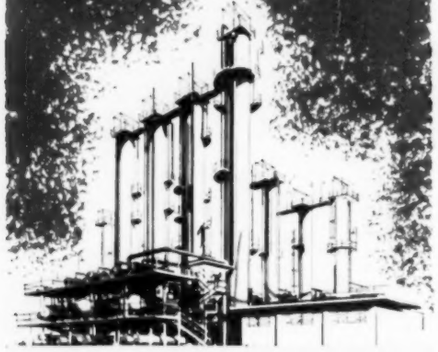

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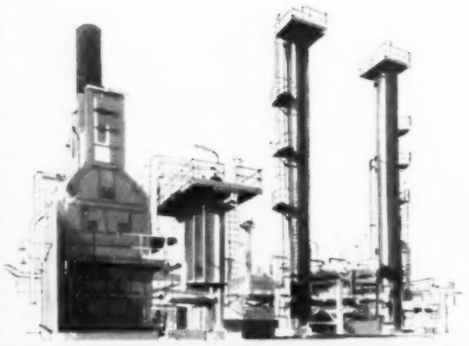

PLATFORMING® produces high octane gasolines, high purity aromatics

HF ALKYLATION makes alkylate, top anti-rumble motor fuel

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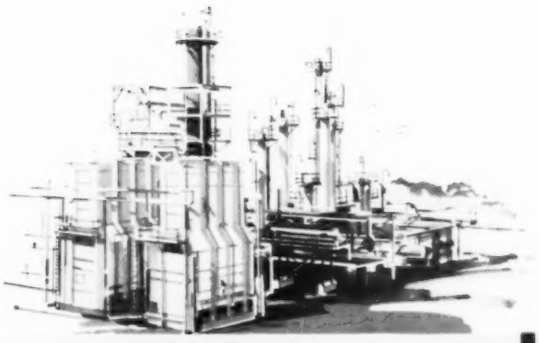
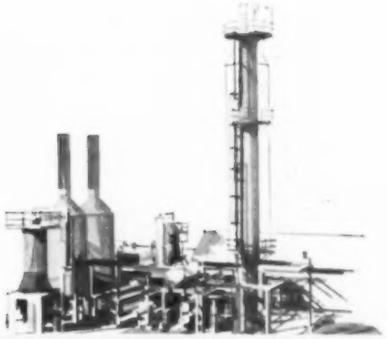
From its nineteen different processes currently available, Universal is in an unparalleled position to provide you with technical knowhow. From analysis of product and market potentials and evaluation of crude supplies through to process design, engineering, operator training and field and laboratory service, UOP is equipped and ready to work with you every step of the way.

Write for information. Consultation is invited on any processing problem.



BUTAMER* a new and practical process for producing isobutane



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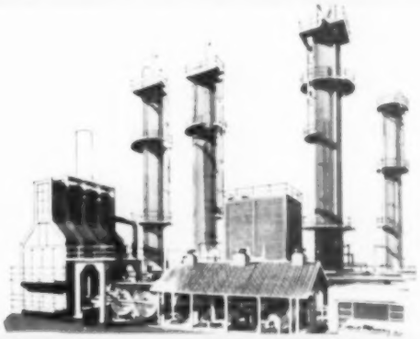

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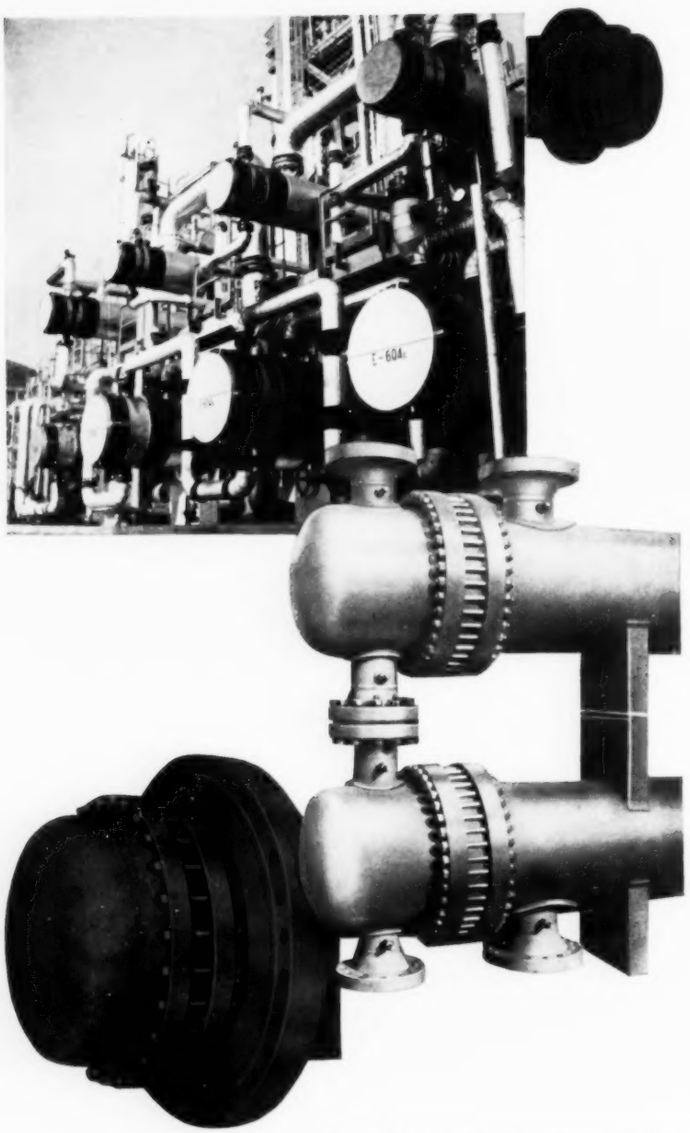

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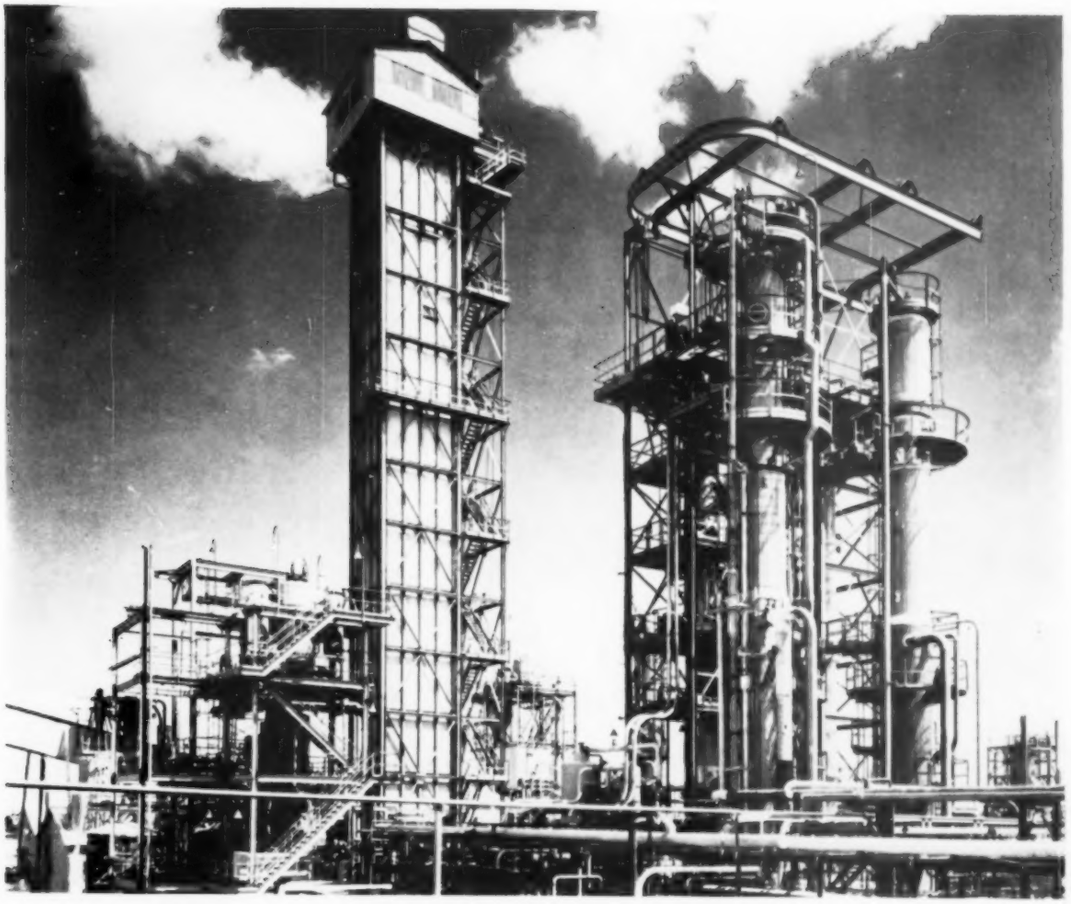

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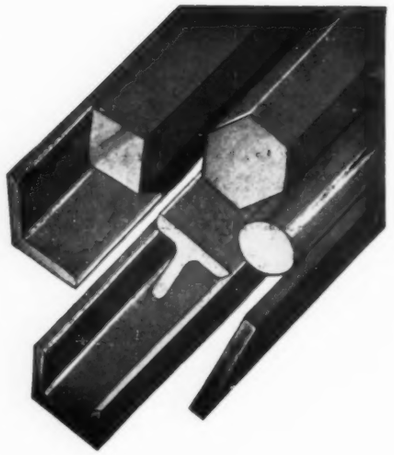

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(Signed) F. J. SANDERS, Engineering Manager
The Standard Oil Company [Ohio]
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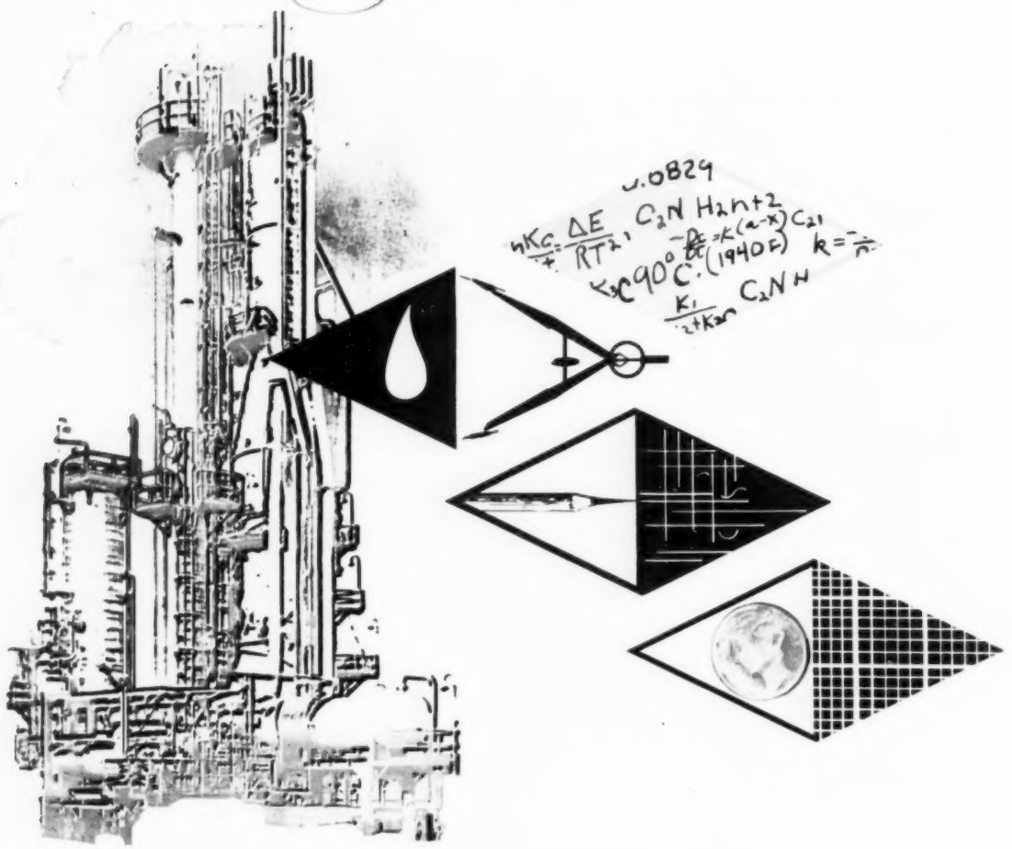

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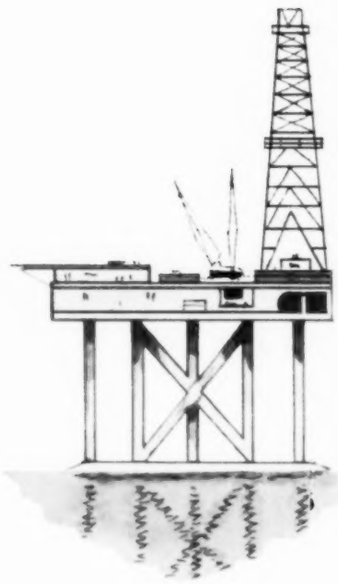
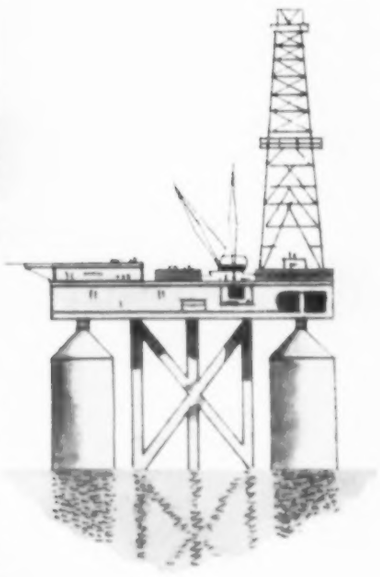


from hydraulically actuated piston-type stabilizing system



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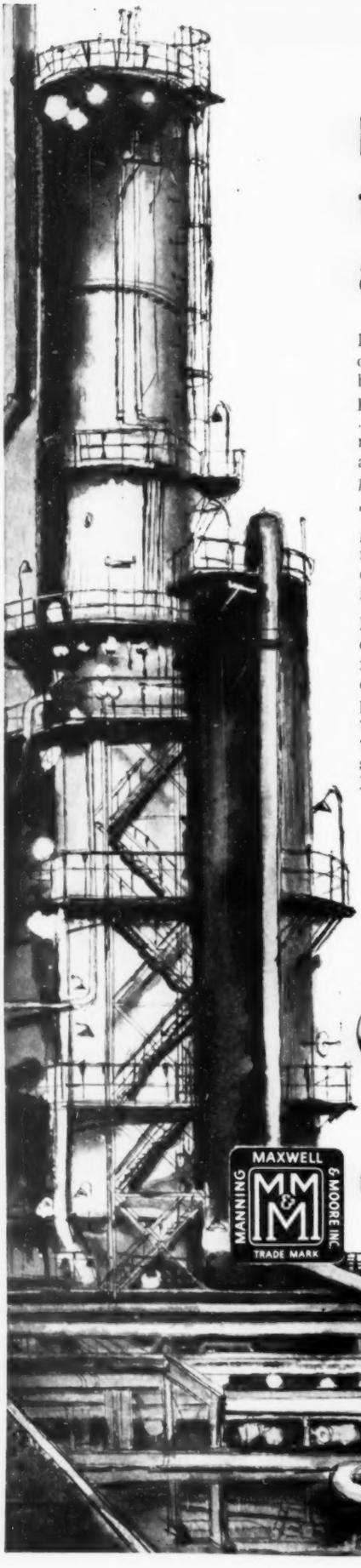

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Hancock Steel Gate and Globe Valves
Hancock Steel "Flocontrol" Valves
Microsen Electronic Process Controls

IN BELGIUM
Ateliers Jaspar, S.A., Liege
Consolidated Safety and Safety Relief Valves

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Consolidated Safety Relief Valves
Consolidated Safety Valves
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Several years ago, when the Government of the Kingdom of Greece decided to construct its own refinery on Greek soil, it was confronted with a number of serious obstacles: financing; engineering manpower to plan, design, and construct the facilities; and a supply of native operators experienced in refinery operations.

To help solve these problems, the Greek Government *twice* selected Hydrocarbon Research, Inc.—originally for design and construction, and later for management-operations. HRI, with its worldwide affiliates, is a completely integrated engineering service organization providing research, development, engineering, construction, operation, financing, and management services to the petroleum industry and other chemical processing industries, anywhere in the world.

From its experience in such matters, HRI was able to assist in all phases of the problem. Long-term financing was arranged; the refinery was designed in the U. S. and Europe, utilizing European materials and equipment; and constructed by HRI-trained Greek workmen under American and European supervision. Contracts for shipments of Middle East crude were negotiated; and the plant has now been put into successful operation by HRI for Hellenic Refining Company, under an HRI management-training team, using Greek workmen and technicians.

HRI has repeatedly demonstrated its abilities to help in the formative, financing, and design stages, as well as in construction and actual long-term operations of refineries and petrochemical plants. HRI can do the same for *you*.

Petroleum and Chemical Processing for Profit

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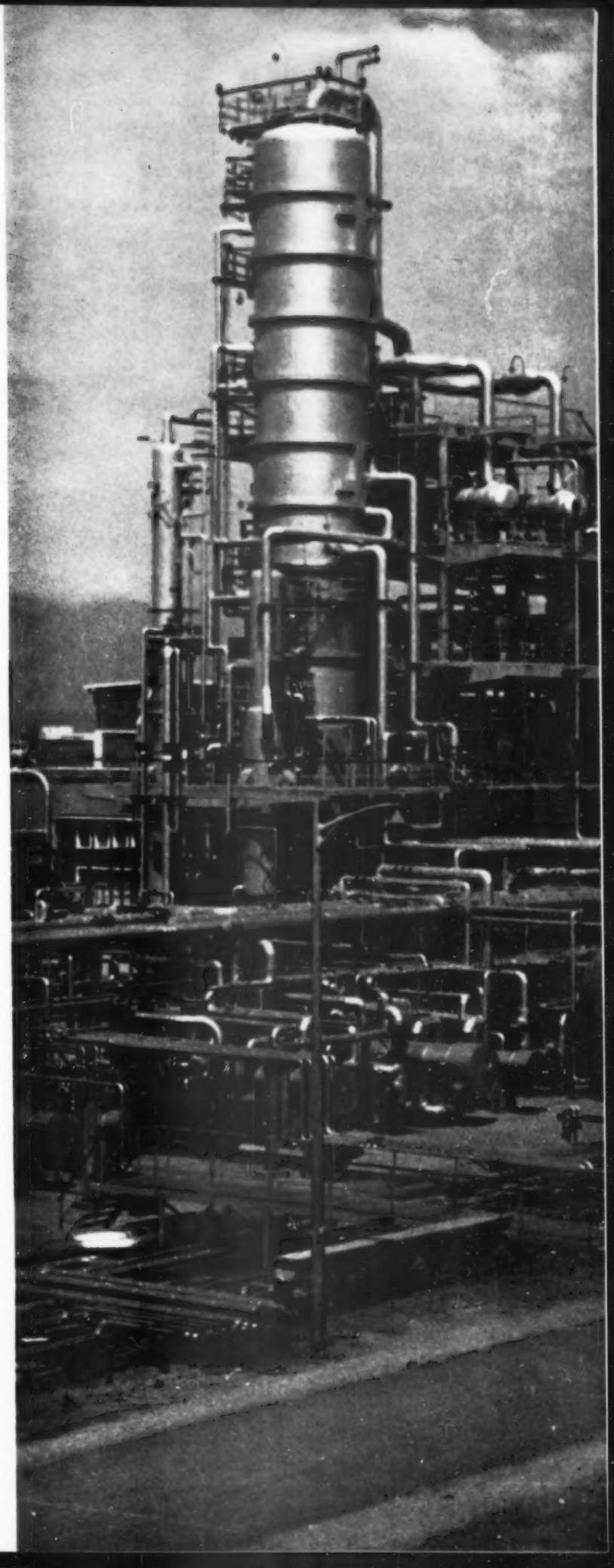
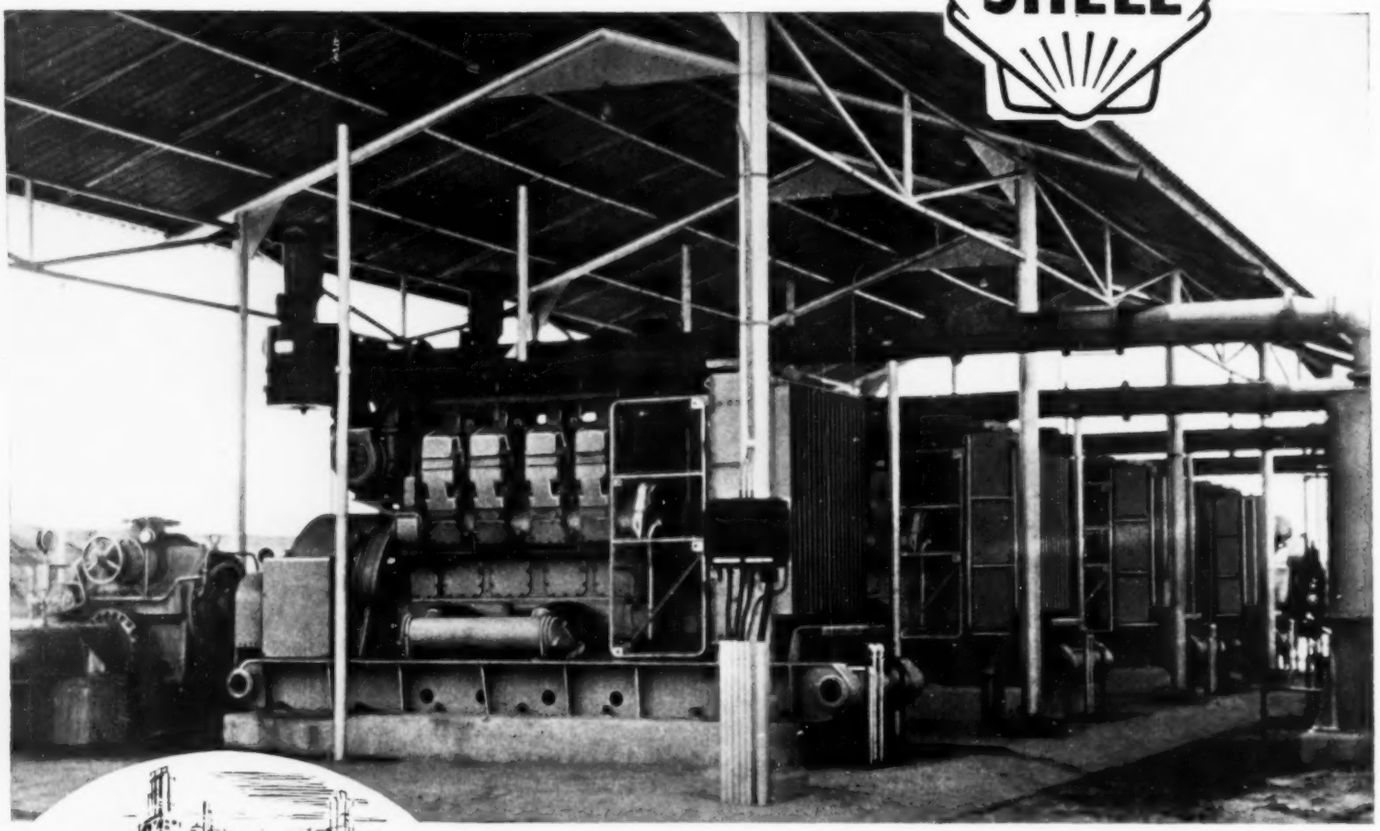
Duesseldorf, Germany
Hydrocarbon Mineraloel, G.m.b.H.,
15-17 Fuerstenwall. Cable: Hydromin.

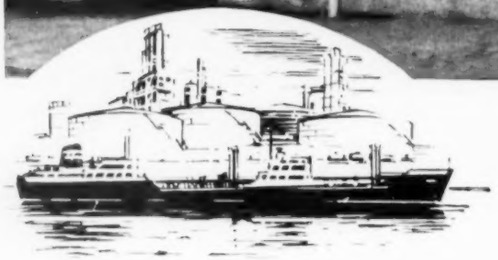
Paris, France
Hydrocarbon Engineering, S.a.r.L.,
44, Avenue des Champs-Elysees

Rio de Janeiro, Brazil
General Heitor Pedroso,
Rua da Quintanda, 20



Packaged pumping power for SHELL





Four 'ENGLISH ELECTRIC' 8SV diesel engine package sets are on duty at the Puerto Miranda loading terminal of Cia. Shell de Venezuela Ltd. These sets, each with a continuous site output of 655 b.h.p. at 720 r.p.m., drive positive displacement pumps through hydraulic couplings to deliver the crude oil to tankers. The speed of the pumps can be varied between 290 and 720 r.p.m.

'ENGLISH ELECTRIC'

diesel engines

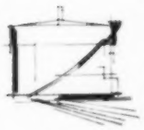
THE ENGLISH ELECTRIC COMPANY LIMITED, MARCONI HOUSE, STRAND, LONDON, W.C.2

Offices and representatives throughout the world

DE.97

General American does a lot more than just build tank cars

General American's design, engineering, fabrication and erection facilities are available to solve many processing and storage problems. Here are some of the products and services offered.



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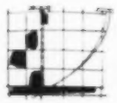
Tanks of all types for every kind of liquid. Cone roof structures and eight WIGGINS CONSERVATION SYSTEMS including floating roof types with the famous WIGGINS safety seal that reduces fire hazard and eliminates losses from thermal breathing.

Kanigen® Chemical Plating

When your equipment must resist corrosion and abrasion, investigate KANIGEN® nickel alloy coating. From process equipment to tank car interiors, KANIGEN does the job economically and efficiently.

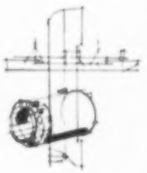


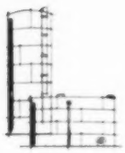
Gasholders

WIGGINS gasholders with patented dry fabric seal. No operating costs, no maintenance problems with the safest of all gas storage structures. Store practically every type of gas in commercial use safely and economically.

Custom Fabrication

All types of vessels, structures and weldments manufactured in our plants to meet all code specifications. Our engineers are on call to help you.



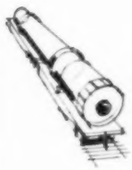


Water Storage

Standpipes, reservoirs and tanks are fabricated in our plants and erected by our specially trained crews

Field Erection

The Field Erection Division maintains experienced crews and modern, efficient erection equipment throughout the country.



Process Equipment

Louisville Dryers, Turbo-Mixers and process equipment of many types including RDC columns for extraction and reaction processes. Our experienced engineers will work with you on design problems. You can test processing ideas in our laboratories. You can rent pilot-scale dryers, mixers and columns for tests in your plant.

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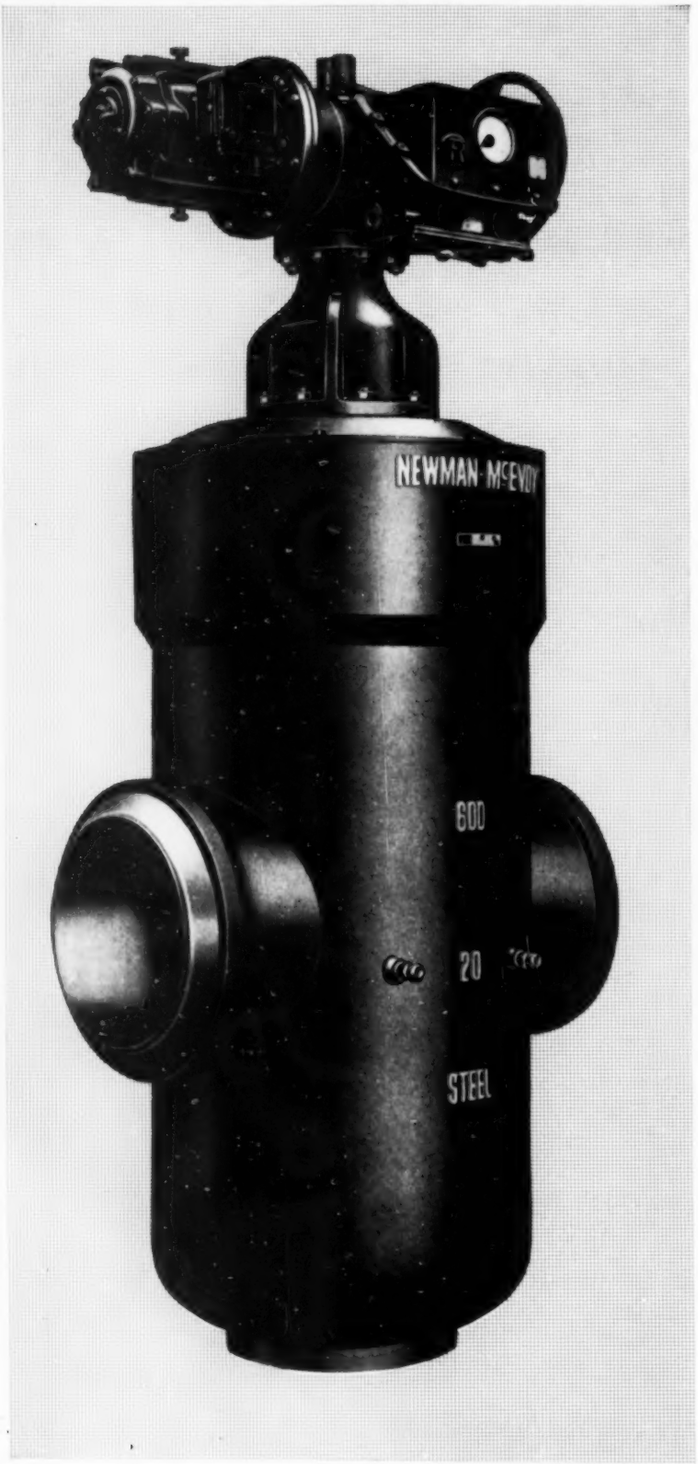

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Telephone: NAILSWORTH 360 (6 lines). Telegrams: Valves, Telex, Stroud. Telex: 43-220.

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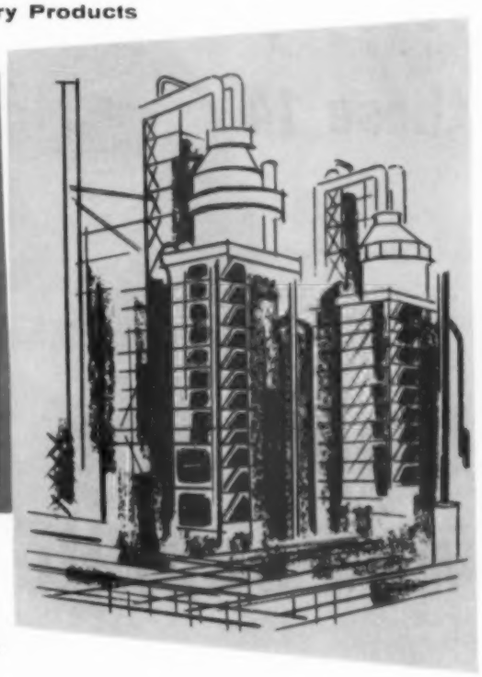

The petroleum industry, throughout the world, relies on A. P. Green high quality refractories for dependable service in thermal and catalytic cracking units, heaters, boilers, stacks, et cetera.

A world-wide network of A. P. Green distributors with engineers experienced in petroleum refining is always ready to help you select the right refractories to do the best possible job . . . at the lowest cost. For one dependable source of a complete line of refractories write . . .

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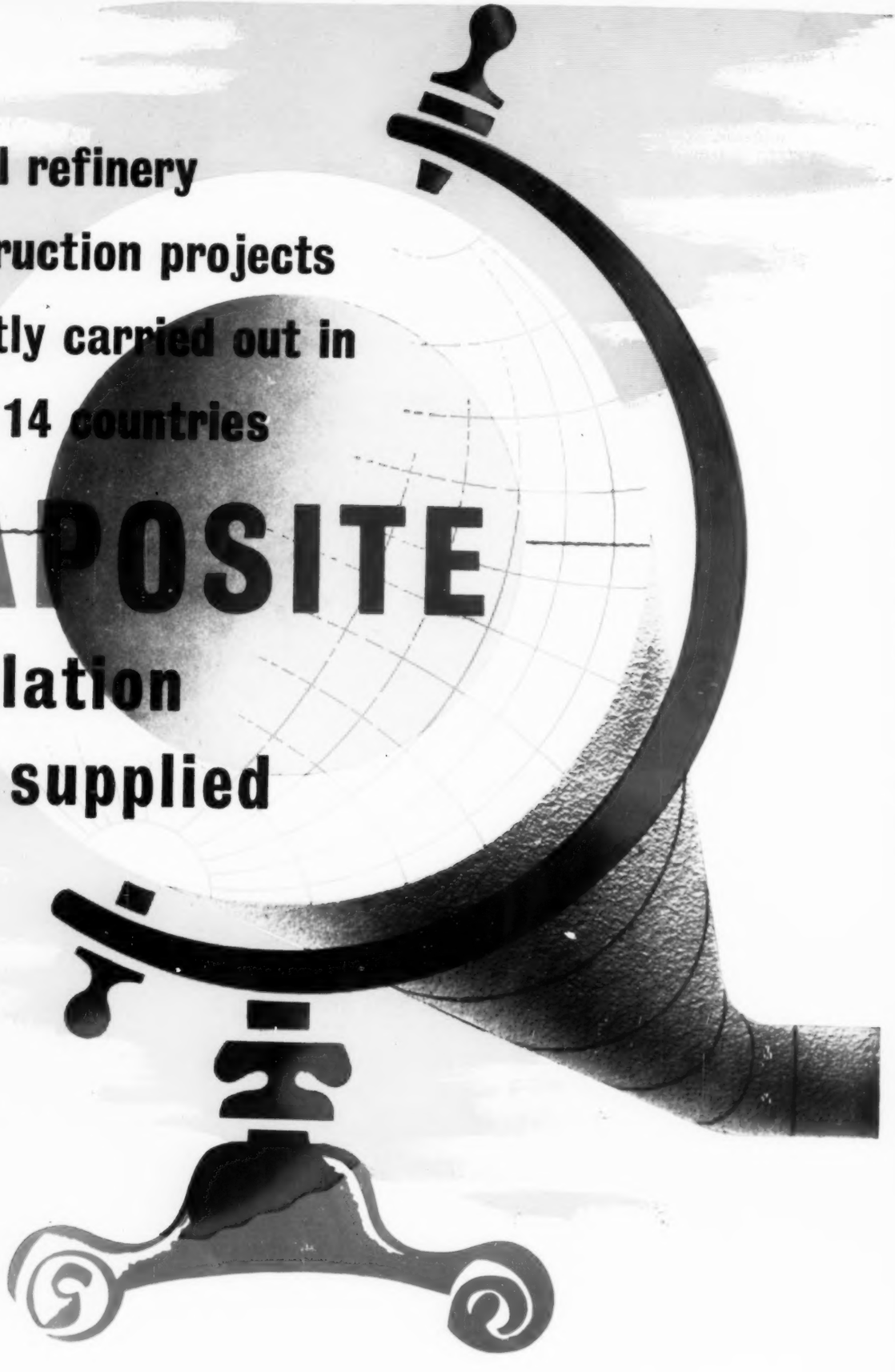

BAHRAIN *at Awali*
for Bahrain Petroleum Co. Ltd. Main Contractor: Foster Wheeler Ltd.

BURMA *at Syriam*
for The Burma Oil Co. (1954) Ltd. Main Contractor: Foster Wheeler Ltd. (London)

CANADA *at Clarkson, Ontario*
for British American Oil Co. Ltd. Main Contractor: The Lummus Co.

COLOMBIA *at Cartagena*
for International Petroleum Co. Ltd. Main Contractor: Bechtel Corporation (Insulation Contractor: Harold Aber & Co.)

ECUADOR *at La Libertad*
for the Anglo-Ecuadorian Oil Co. Ltd. Main Contractor: Procon (G. B.) Ltd.

ENGLAND *at Kent Oil Refinery*
for The British Petroleum Co. Ltd.

FRANCE *at Raffinerie de Normandie*
for Compagnie Francais de Raffinage. Main Contractors: Kellogg International Corporation and Foster Wheeler Ltd. (France). (Insulation Contractor: Soc. Technisol).

IRAQ *at Daura, near Baghdad*
for Iraq Government Oil Refinery Administration. Main Contractor: Foster Wheeler Ltd. (London).

ITALY *at Genoa*
for Raffineria Dottore E. Garrone. Main Contractor: C. T. I. P.

KUWAIT *at Akmadi*
for the Kuwait Oil Co. Ltd. Main Contractor: Bechtel-Wimpey and E. B. Badger & Sons Ltd.

THE NETHERLANDS *at Pernis*
for N. V. de Bataafsche Petroleum Maatschappij.

NETHERLANDS ANTILLES *at C.P.I.M. Refinery, Curacao*
for Royal Dutch-Shell Group.

SCOTLAND *at Grangemouth*
for British Hydrocarbon Chemical Co. Ltd. Main Contractor: E. B. Badger & Sons Ltd.

VENEZUELA *at Maracaibo*
for The Richmond Exploration Co. Main Contractor: The Lummus Co.

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Speedy and economical application . . .
long-lasting and efficient protection . . .
strong, tough and resilience to withstand rough handling and transportation . . .
superior insulating properties due to manufacture from long-fibred Amosite asbestos—
these are the reasons why CAPOSITE
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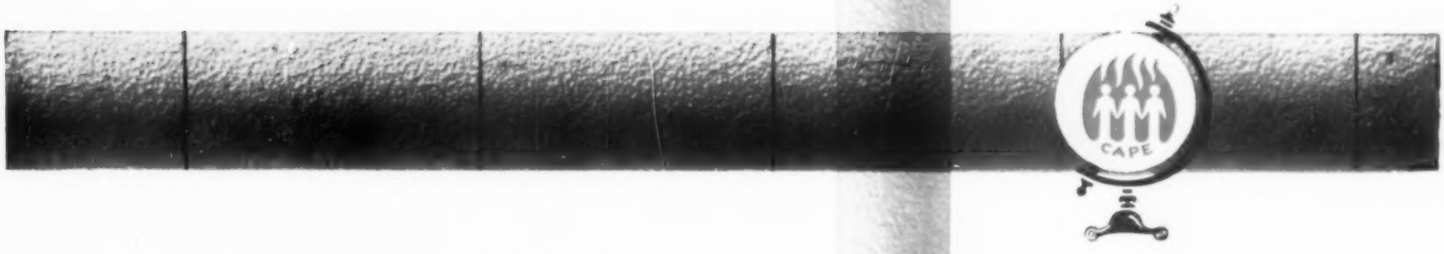
FRANCE as 'Isolamiante' by Isolamiante SA.
HOLLAND by J. de Boer & Co.
SPAIN by Messrs. Eduardo Rosa



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FOR THE OIL INDUSTRY

Hot sun, a salt-laden atmosphere, winds charged with abrasive sand . . . Venezuela is hardly the ideal spot for costly equipment. Yet wherever oil flows, plant must be installed — and protection is worth its weight in gold.

GROUP 37

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Group 37 is one of the most important of International's protective paints for the oil industry. Based on epoxide resins it has all the qualities of hardness, flexibility and resistance to chemicals, abrasion and corrosion for which these specialised paints have so rapidly become famous.

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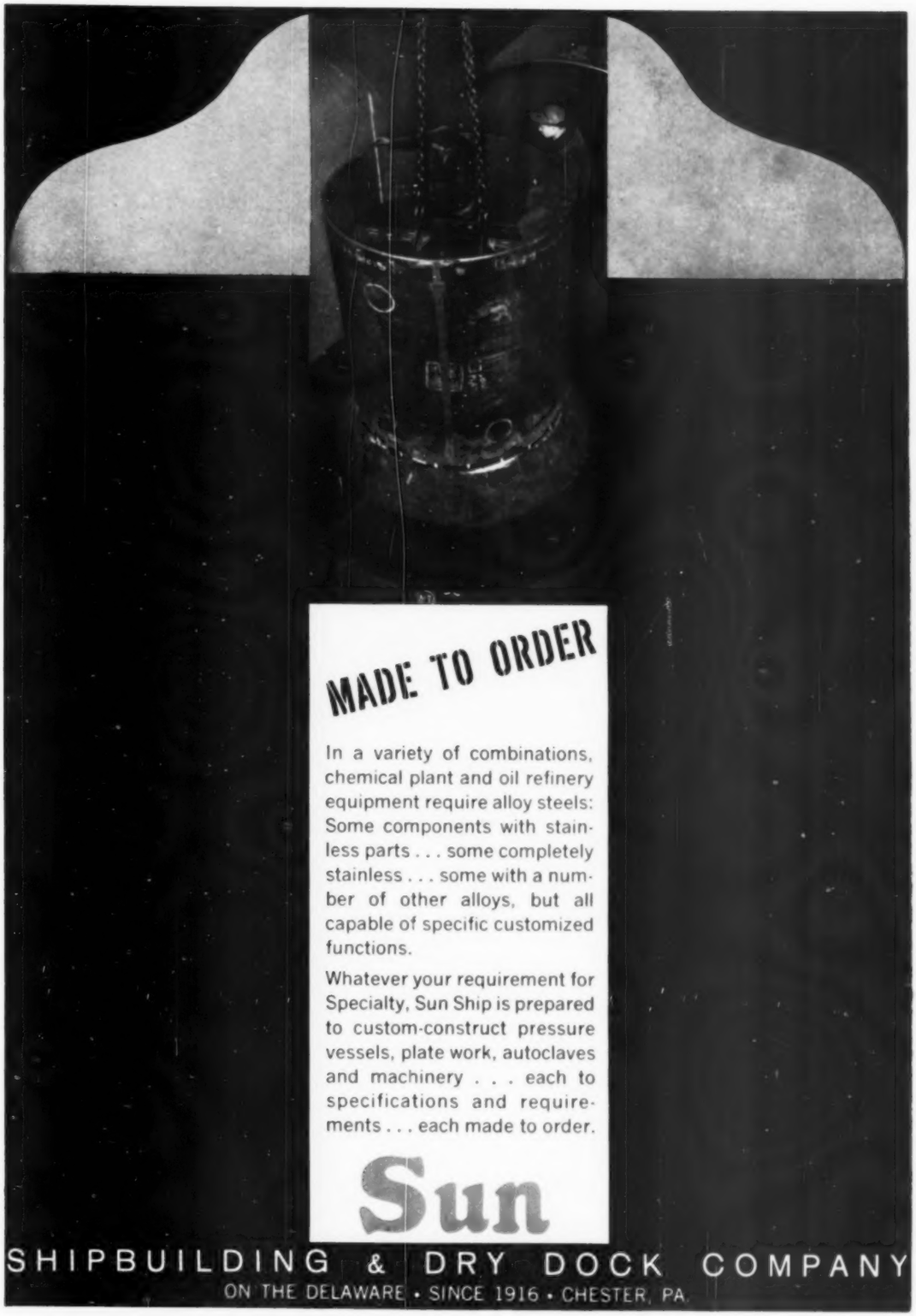
A WORLD-WIDE PAINT ORGANISATION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In a variety of combinations, chemical plant and oil refinery equipment require alloy steels: Some components with stainless parts . . . some completely stainless . . . some with a number of other alloys, but all capable of specific customized functions.
Whatever your requirement for Specialty, Sun Ship is prepared to custom-construct pressure vessels, plate work, autoclaves and machinery . . . each to specifications and requirements . . . each made to order.
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HOW WESTINGHOUSE GAS TURBINES CAN IMPROVE KEY OIL OPERATIONS

PRODUCTION/BOOSTING OIL YIELD

Largest single concentration of gas turbines in the world is the battery of 12 Westinghouse units at Creole Petroleum Corporation's Conservation Plant Tia Juana 2 on Lake Maracaibo, Venezuela, shown above. Their 96,000 horsepower drives centrifugal compressors to help Creole recover substantial quantities of oil through repressurization and also to conserve natural gas. Creole has ordered 14 more Westinghouse gas turbines for other conservation projects.

REFINING/SALVAGING WASTE HEAT

It's like "found money" when you use Westinghouse gas turbines to drive air and gas compressors in the cat-cracking process. In addition to the power they generate, 70 percent of the heat energy in the exhaust can be recovered. Usual method is to feed the exhaust gas to a boiler for producing process steam.

PIPELINE/MORE THROUGHPUT AT LESS COST

Operating costs drop with Westinghouse gas turbines powering your centrifugal compressors or pumps. Reduction gears are usually not required, for one thing. For another, these turbines can be fueled with oil or gas from the pipeline. And since little or no cooling water is needed, you can locate a Westinghouse gas turbine almost anywhere.

For an interesting booklet on Westinghouse products serving the oil industry, write for booklet INT-7398 to Petroleum Sales Department, Westinghouse Electric International Company, 40 Wall Street, New York 5, U. S. A.

Westinghouse manufactures a complete line of electrical equipment for every phase of the oil industry:

DRILLING
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TRANSPORTATION
REFINING

YOU CAN BE SURE...IF IT'S Westinghouse

... working partner of the oil industry

...he's a few hours from anywhere

Once this boy would have lived a secluded life, far from the outside world. Today the world comes to his door. He learns many things, such as how power-driven machines can help him to meet the needs of his people.

Throughout Asia, Africa and the lands of the Pacific, new industries call for more oil. And Standard-Vacuum is doing its best to meet the demand. Stanvac finds the oil, transports and refines it, then delivers the finished products—all within the area where Stanvac operates.

This is a big job and a worth-while one. Stanvac is proud and privileged to be able to do it well.

STANDARD-VACUUM OIL COMPANY POWERS PROGRESS

White Plains, New York

OIL
REFINERY
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MATTHEW HALL

GROUP OF COMPANIES

MATTHEW HALL & CO. LIMITED

CHAIRMAN'S STATEMENT

The Thirty-second Annual General Meeting of Matthew Hall & Co. Limited was held on 19th May, 1959, at Matthew Hall House, Dorset Square, London.

The following is an extract from the circulated statement of the Chairman, Mr. Bertram Baden, M.C., S.B.St.J., M.I.H.V.E.

The year 1958 produced an increased group trading profit of £491,293 as compared with £321,854 for 1957 This was mainly due to the number of large long term contracts reaching completion during the year. The net profit after all charges including taxation, was £201,152 (1957—£99,319). The directors recommend a dividend of 30% (1957—30% on smaller capital, plus a capital dividend of 5½% free of tax).

It is also recommended that £240,000 of the Company's reserves be capitalised and applied in paying up in full 960,000 ordinary shares of 5/- each to be issued to members on the basis of one new ordinary share for each existing ordinary share. It is possible to propose such a substantial capitalisation because, during the current year, the Company's reserves will be considerably strengthened by a transfer of reserves from a subsidiary Company which is being liquidated under a reorganisation of the group's overseas activities so as to take advantage of the benefits afforded to Overseas Trade Corporations.

It is not proposed to maintain the same rate of dividend on the increased capital, but it is hoped, apart from unforeseen circumstances, that the total amount distributed next year by way of dividend will not be less than that for 1958.

Our order book is substantial although it does not reach the record levels achieved during the past two years. Competition is keen, especially in South Africa.

NUCLEAR ENERGY DIVISION

Orders included a contract for the installation of the 7,000 ton electro-magnet for the 7 GeV proton synchrotron at the Rutherford High Energy Laboratory, Harwell.

Our work on a land-based prototype nuclear submarine involves special welding techniques to Lloyd's Class 1 requirements.

CHEMICAL, OIL REFINERY AND INDUSTRIAL ENGINEERING DIVISION

The design, procurement and construction of large oil and chemical installations were among contracts secured. These included a styrene monomer plant and extensions to an oil refinery in the West Indies and to a copper refinery in Northern Rhodesia.

Work was completed on a new chemical plant producing fuel for rocket motors; this is the first of its kind in the United Kingdom and one of the largest in the world.

The order was secured for the erection of a second 55,000 tons per annum paper making machine.

SPRINKLERS AND FIRE PROTECTION

Contracts were received for sprinkler systems to paper mills, a large power station, laboratories, garages, stores and office blocks, including the main areas of the new American Embassy office building in Grosvenor Square.

MATTHEW HALL (PTY.) LIMITED, SOUTH AFRICA

Contracts obtained included air conditioning, sprinkler systems, plumbing, electrical and mechanical services. Work on chemical, oil and industrial plants continued.

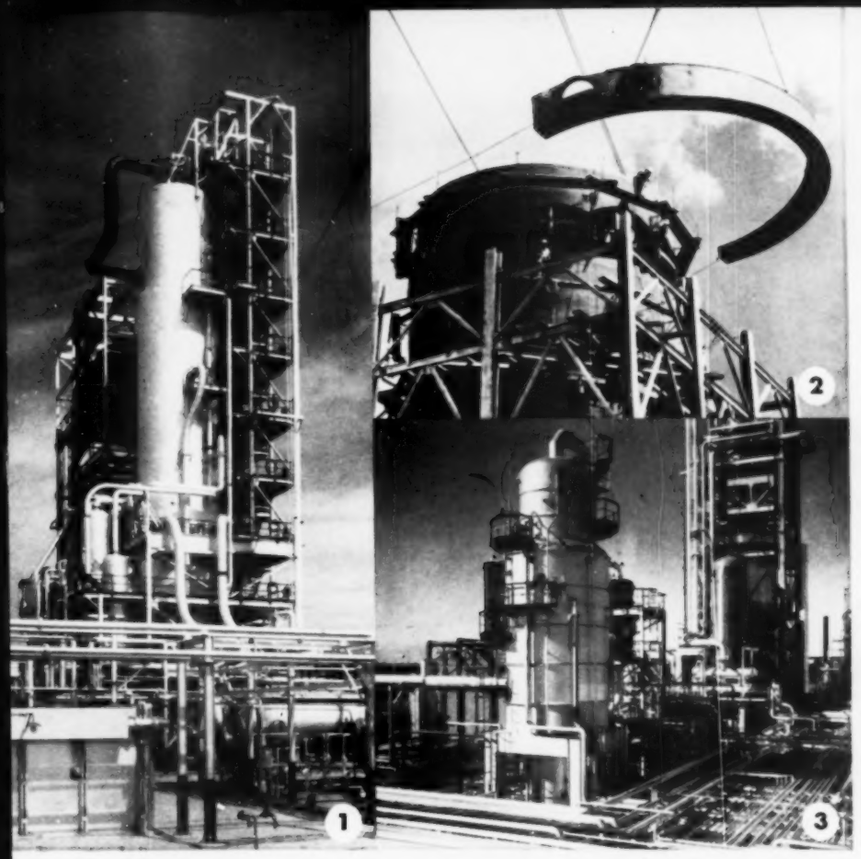
The report and accounts were adopted.

Propellers of Heliston design in Stone's Bronze and Novoston alloy are well known in this country and throughout the world and for many years have been accepted as the solution to many of the problems associated with ship propulsion. Stone's Charlton propeller foundries are probably the largest and most specialised of their kind in the world. Production is backed by extensive laboratory facilities. Each propeller, whether large or small, is a high quality casting, formed to close tolerances and finished machined.

Heliston propellers in Stone's Bronze

J.STONE & CO. (CHARLTON) LTD.

OCEANIC HOUSE 1a, COCKSPUR STREET, LONDON S. W. 1.

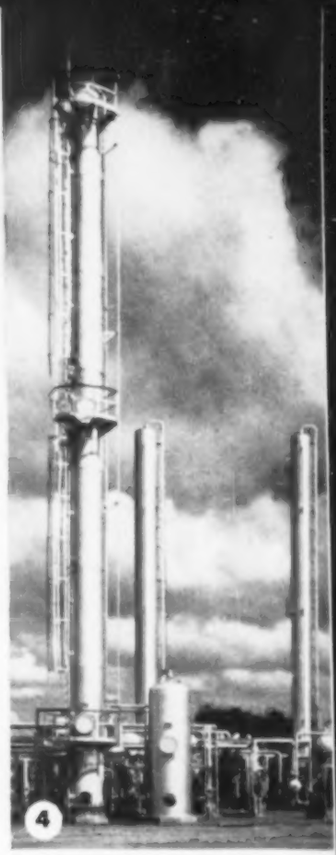


1. 9-ft. diam., 116-ft. high fractionating tower built for Creole Petroleum Corp. Ltd. at Amuay Bay in Venezuela.

2. Air duct section for *first* type TCC Thermofor unit built, is raised at Capuava Refinery in Soo Paulo, Brazil.

3. 63-ft. high vacuum column partially clad with 405 stainless steel built by CB&I for Petroleo Mexicanos Minatitlan refinery.

4. Gasoline stabilizer, high and low pressure absorbers and oil still—just a few of the extensive CB&I-built equipment erected for Phillips Oil Company at San Roque, Venezuela.



Where There's Refining ...There's CB&I

The ability to expertly coordinate the design, engineering and fabrication and to erect tanks and refinery processing structures *anywhere in the world* is a specialty and an art with CB&I. To petroleum executives everywhere, CB&I offers the advantage of one source and one responsibility to meet the most exacting processing requirement. CB&I offers too, the distinct advantage of placing our *global representation* at your service. It is for these reasons that, wherever in the world you find refining . . . you'll find the experienced *craftsmanship in steel* that is CB&I. Write our nearest office for details.

Chicago Bridge & Iron Company

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P66CB

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The vast technical experience of the ATE group of companies covers all problems associated with remote control, telephone switching and transmission. This unequalled practical experience, backed by extensive research, is of enormous value when these systems need to be integrated in a comprehensive network. Substantial economies are effected if this integration is achieved in the planning stage.

The ATE group can provide facilities for:—

- **Remote control of oil flow in tank farms**
- **Remote control of oil to tankers**
- **Remote indication of oil level and temperature**
- **Remote control of pumping at intermediate stations**

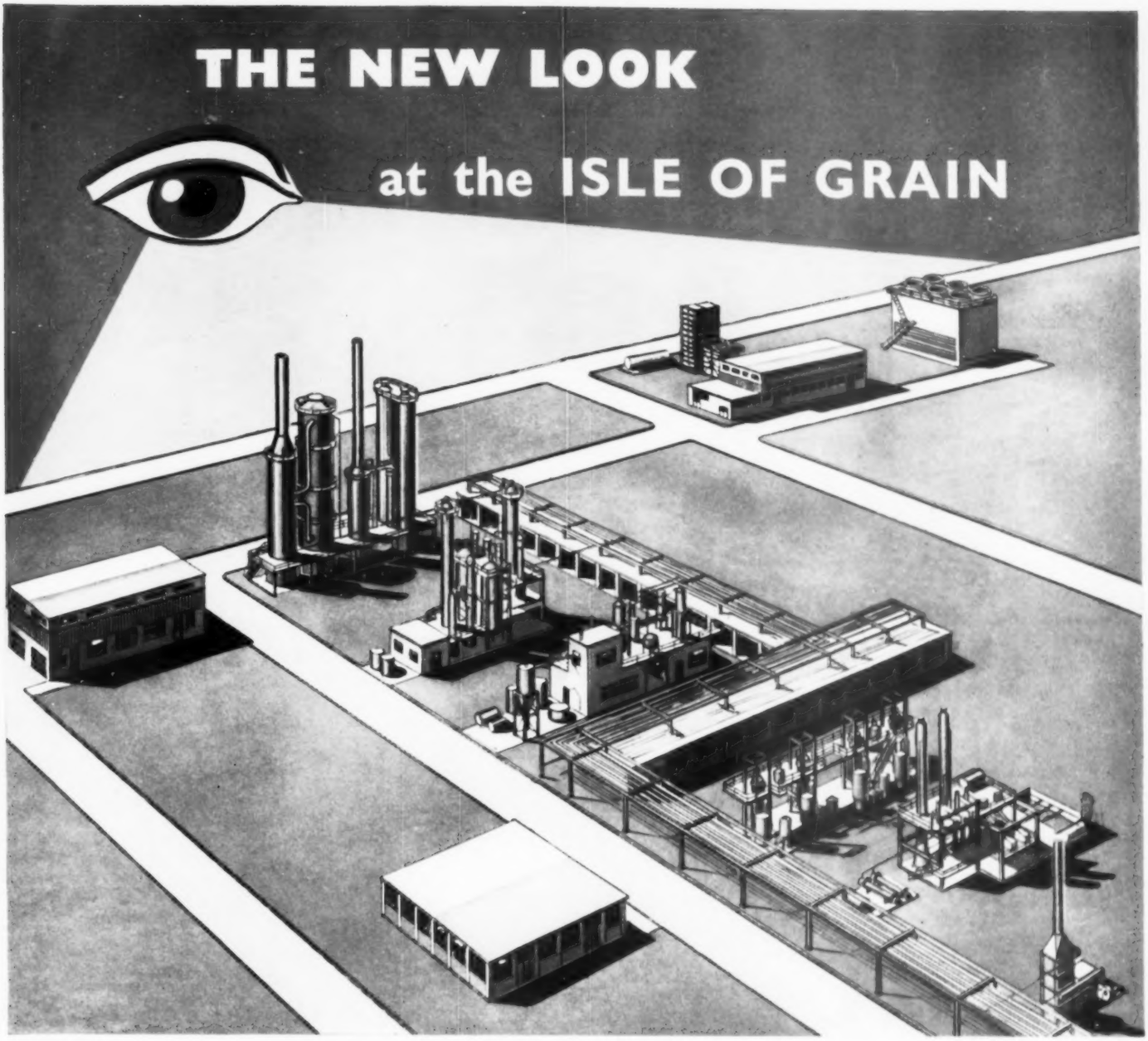
These facilities can be extended over any distance by suitable transmission equipment by line or radio.
The ATE group is in close touch with the principal suppliers of oil pumping equipment. It offers a comprehensive consultative service backed by adequate manufacturing resources for the planning and installation of communication networks for oilfields and refineries in any part of the world.

AUTOMATIC TELEPHONE & ELECTRIC CO. LTD.

STROWGER HOUSE, ARUNDEL STREET, LONDON, W.C.2, ENGLAND

AT 4641

THE NEW LOOK
at the ISLE OF GRAIN



The Oil Gasification Plant to be built by Woodall-Duckham Construction Company Ltd. at the South Eastern Gas Board's Isle of Grain Works.

The Installation will include Shell Gasification Plant with associated Oxygen Plant as well as Ancillary Plants for H_2S removal, CO conversion, CO_2 removal and power generation. It will produce more than 18 million cubic feet of gas daily and is to be completed in 1960.

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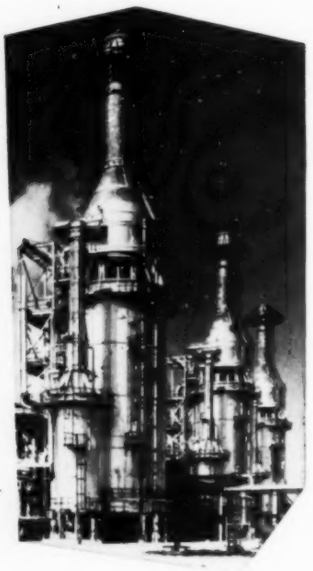

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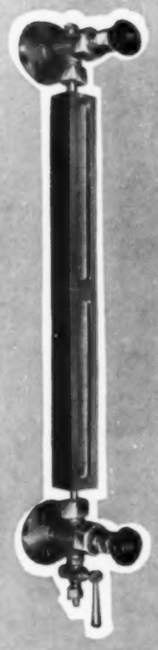

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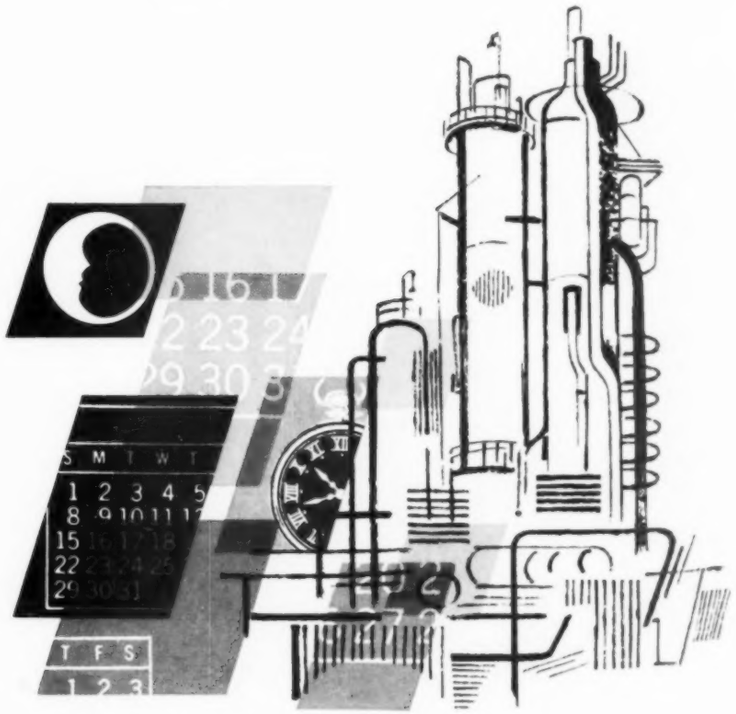

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158 ton fusion welded tower for Fawley

Shown below, in transit to the Esso Refinery, Fawley, is a 105-ton section of a 158-ton, 137 ft.-high stabilising tower fabricated by BABCOCK fusion-welding, to the order of the Lummus Co. Ltd., for Esso Petroleum Co. Ltd.

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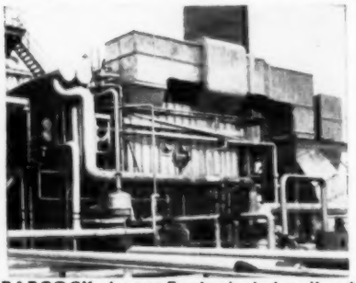

BABCOCK plant at Fawley includes oil and gas fired boiler plant. Above: one of the outdoor type FH Integral Furnace boilers.

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$175 Million in New Refineries

General Petroleum Corporation. Ferndale, Washington. 37,000 barrels per day. Initial operation, 1954.

Shell Oil Company. Anacortes, Washington. 50,000 barrels per day. Initial operation, 1955.

The Texas Company. Puget Sound Works, Anacortes, Washington. 45,000 barrels per day. Initial operation, 1958.

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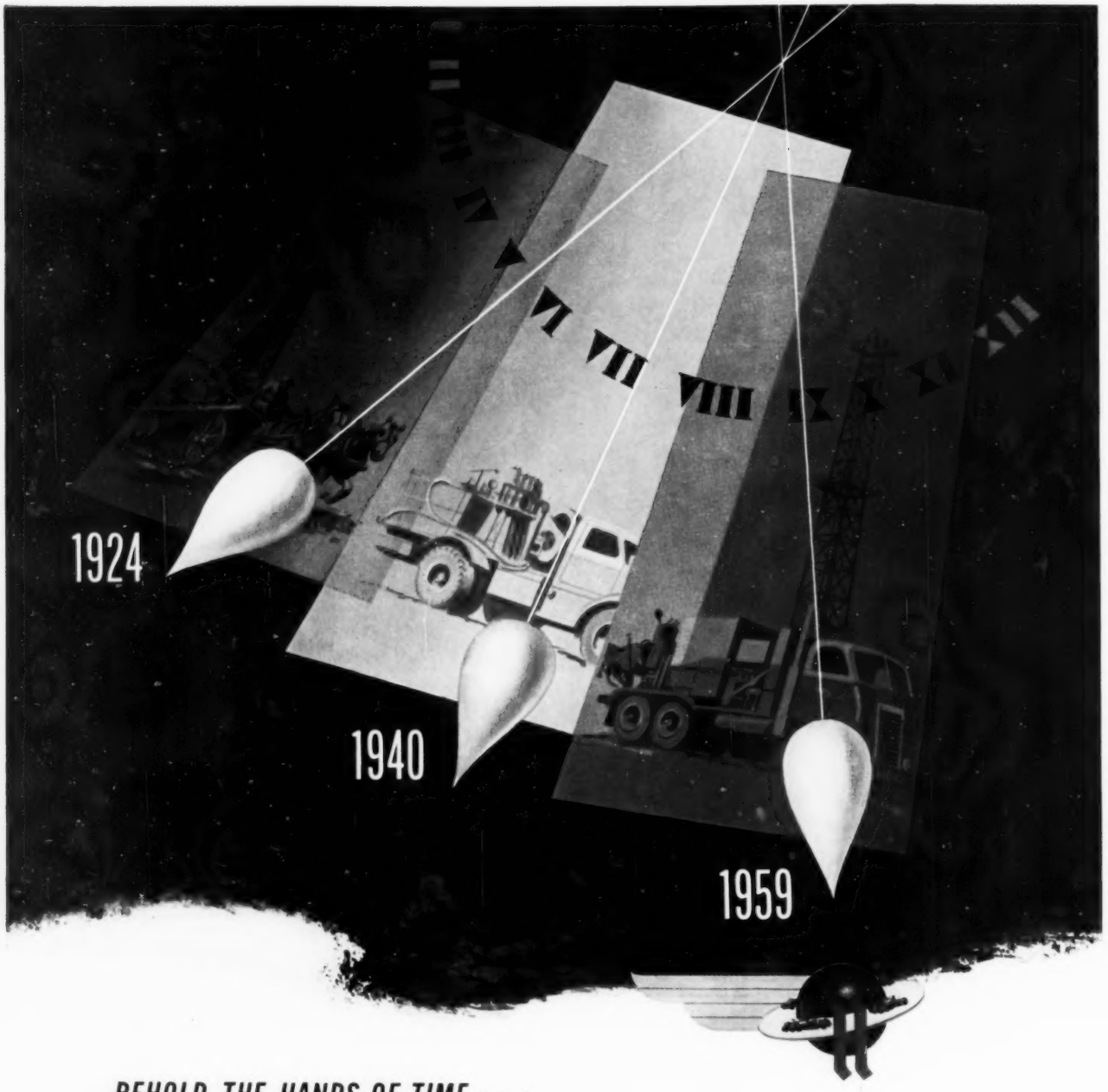

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Time is only a measure—in man, it defines the milestones of progress—Birth, growth and contributions to the community of mankind. In a company, time records not only a measure of birth and growth, but by each passing year, it reflects the position in the community of commerce that has been achieved.

Our time measure is now 35 years . . . from the early days of "Hard knocks and trial by error" to today's world wide establishment of services, equipment, products and men at the highest degree of technological knowledge.

With pardonable pride, we too, reflect on the spirit of wholesome and friendly cooperation we have enjoyed with the oil industry over this span of time. Thanks to your confidence, our 35th birthday is but a landmark on the progressive road to a more profitable future.

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Sharp rise in Eastern Hemisphere refining capacity forecast

Crude charging capacity of the world's oil refineries is expected to increase 23.5% in the next four years. Current capacity is 22,939,100 barrels per calendar day and this expected to rise to 28,363,600 b/d by 1963.

A major part of the increase will be built in the Eastern Hemisphere. Reports gathered by World Petroleum suggest that there will be an expansion of 45.5% in the east as compared with 9% in the western hemisphere. The eastern hemisphere starts from a somewhat lower base but the expansion will be much larger on both a volume and a percentage basis. Western hemisphere capacity is expected to rise 1,244,300 b/d from the present level of 13,796,400 to 15,040,700 b/d. Growth in capacity in the eastern half of the world is expected to total 4,180,200 b/d, from the present level of 9,142,700 to 13,322,900 b/d.

Most spectacular increase is that proposed by the Communist group of nations. The current 7-year plan contemplates an expansion of 330% and plants with an aggregate capacity of 1,300,000 b/d are said to be now under construction. For the present 4-year period it is estimated that crude capacity will rise 90%.

In Western Europe the rate of growth in still capacity is expected to be 31.6% in the four years, from 3,721,900 to 4,918,900 b/d. Asia is planning a similar increase, 35% from the present 1,255,300 to a 1963 capacity of 1,700,600 b/d.

North American expansion is expected to continue at a rapid pace outside the United States where current still capacity is somewhat more than adequate for the immediate future. Mexico plans to enlarge still capacity by 39% in the next four years and Canada by almost 30%. South American crude capacity probably will rise about 22.8% to 1,738,000 b/d by 1963. Argentina and Brazil will be large contributors to the growth.

Construction of specialized processing units will be at a faster pace than crude stills during the next four years but the change will not be uniform because of the variation in marketing problems of refiners in various parts of the world.

In the Eastern hemisphere catalytic cracking construction is lagging and refiners are obtaining octane improvement without expansion of motor fuel output through the building of reforming units. The Soviet Union has announced that its reforming capacity will be increased from 1,600 to 1,800% in the next seven years. No data was given about the base on which the increase is figured but it may be presumed that at the beginning of the plan period capacity was not large. Eliminating the Communist nations for want of past data the remainder of the world will increase reforming about 14.7% and catalytic cracking 9.9%.

Hydrogen processing capacity of the world—outside of the Communist group—will rise 24.8% by 1963. The rate of increase as between the western and eastern hemispheres will not differ greatly.

Most spectacular increase in down-stream processing will be in alkylation in the western hemisphere.

Oil Refineries of the World

Summary of Crude and Special Processing Capacities 1959 with Estimates for 1961 and 1963

Country	No. of Plants	Year	Crude Capacity	Thermal Capacity	Catalytic Operations					
					Cracking	Reforming	Poly	Hydrogen Processes	Alkylation	Lube
Canada	41	1959	851.0	106.3	271.4	151.6	20.1	141.5	5.7	6.7
	43	1961	988.9	119.3	357.6	184.1	22.5	138.4	7.2	6.7
	43	1963	1,103.7	119.8	410.1	207.2	22.5	138.4	7.2	6.7
Mexico	8	1959	361.0	35.0	35.0	12.0	3.9	48.0	1.2	3.2
	9	1961	486.0	56.7	55.0	32.0	4.7	48.0	2.7	3.2
	9	1963	501.0	56.7	55.0	32.0	4.7	48.0	2.7	3.2
United States	293	1959	10,200.0	2,000.0	3,100.0	1,600.0	130.0	1,540.0	340.0	163.0
	293	1961	10,400.0	2,000.0	3,200.0	1,700.0	132.0	1,750.0	375.0	163.0
	293	1963	10,600.0	2,000.0	3,300.0	1,800.0	134.0	2,000.0	425.0	163.0
Total North America	342	1959	11,412.0	2,160.6	3,406.4	1,763.2	154.0	1,729.5	346.9	172.9
	345	1961	11,874.9	2,176.0	3,612.6	1,916.1	159.2	1,936.4	384.9	172.9
	345	1963	12,204.7	2,176.5	3,765.1	2,039.2	161.2	2,186.4	434.9	172.9
Cuba	6	1959	85.2	0.6	22.0	10.7	1.0	10.5		0.2
	7	1961	103.2	0.6	22.0	10.7	1.0	10.5		0.2
	7	1963	103.2	0.6	22.0	10.7	1.0	10.5		0.2
Guatemala	0	1959	0							
	1	1961	2.8							
	1	1963	2.8							
Jamaica	0	1959	0							
	1	1961	15.0							
	1	1963	15.0							
Netherlands Antilles	2	1959	650.0	426.0	78.0				9.5	6.6
	2	1961	650.0	426.0	78.0				9.5	6.6
	2	1963	650.0	426.0	78.0				9.5	6.6
Panama	0	1959	0							
	1	1961	60.0							
	1	1963	60.0							
Puerto Rico	2	1959	83.0	10.0	30.8	7.4	1.7		2.8	
	2	1961	98.0	20.0	30.8	7.4	1.7		2.8	
	2	1963	98.0	20.0	30.8	7.4	1.7		2.8	
Trinidad	3	1959	152.0	47.5	25.0	8.0	4.7	10.0	1.8	
	3	1961	169.0	47.5	25.0	8.0	4.7	10.0	1.8	
	3	1963	169.0	47.5	25.0	8.0	4.7	10.0	1.8	
Total Central America & Carribean	13	1959	970.2	484.1	155.8	26.1	7.4	20.5	14.1	6.8
	17	1961	1,098.0	484.1	155.8	26.1	7.4	20.5	14.1	6.8
	17	1963	1,098.0	484.1	155.8	26.1	7.4	20.5	14.1	6.8

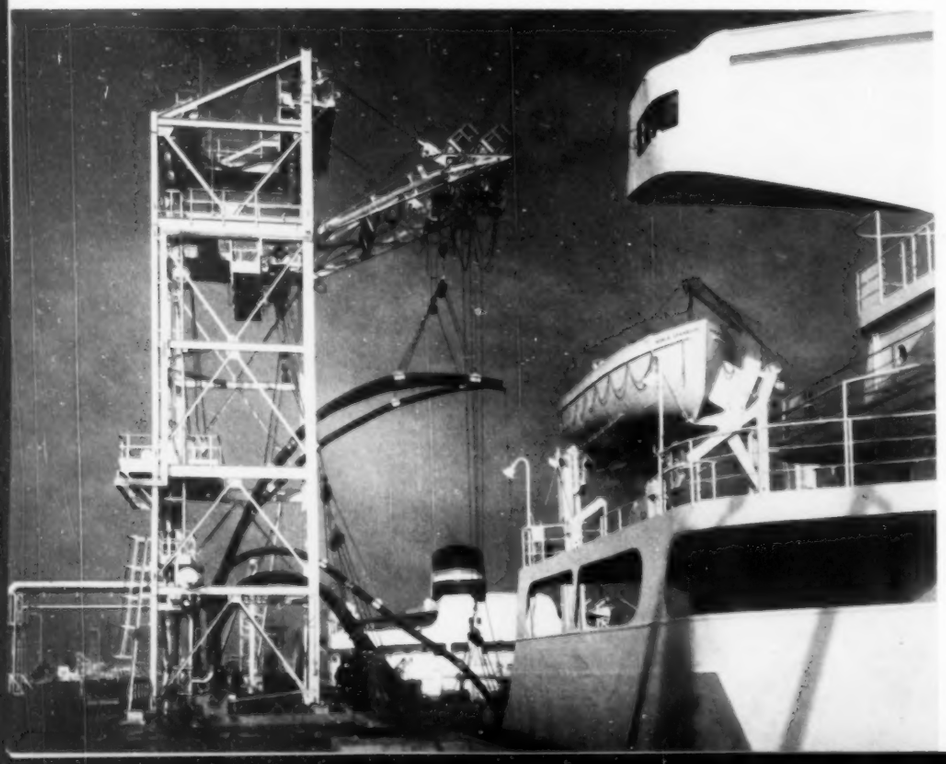
(Continued on page 98)

Marine terminal at Southampton Water for Esso's Fawley refinery. The 4,200 ft. jetty can accept 65,000 dwt tankers fully loaded.

UK refinery capacity now 41.5 million tons a year

by Cecil W. Wood

A "U" boom hose handling structure unloading the World Grandeur at Esso's No. 5 jetty. The 70-foot-high structure carries five 10-inch cargo hoses, each capable of accepting 1,200 tons per hour.



IT is generally agreed that something of the order of £300 million has now been spent since the war in establishing a British petroleum refining industry. This has been amply repaid in a number of directions.

At almost 33.0 million tons (all tonnage figures in this review are long tons), UK refinery throughput in 1958 reached a new high level by a large margin. The total compares with 27.8 million in 1957—a year under the influence of the Suez Canal closure—and 28.7 million in 1956. Last year's figure represents an increase of 18.4% over 1957 and 14.8% over 1956 (the last normal year).

A noteworthy point is the steadily rising level of throughput as the year progressed. Figures published in the *Monthly Digest of Statistics* (Central Statistical Office) show that over the first quarter of 1958 refineries were operating at a 30.0 million-ton-per-year rate, rising to 31.6 million in the second, 34.1 million in the third, and to a rate of 36.0 million tons a year in the final quarter. In fact, for December alone, the throughput of 3,063,200 tons represented, the unprecedented yearly rate of 36.8 million, or practically the same as the then total for UK

refining capacity. The first two months of 1959 (the last figures available at the time of writing) saw a further rise: at 3,132,000 tons the average represented a yearly rate of 37.6 million.

Output of the principal products in the last three years is given in summary form in Table I—the points of particular interest being the increasing proportion of gas, diesel, and fuel oils made, and the decreasing proportion of motor and aviation spirits.

Refinery capacity determination is certainly the reverse of an "exact science." The figure relating to any individual plant, and thus the total for any country as a whole, can vary very greatly and, to make statistics more liable to differences, legitimately so. A wide gulf can be between design capacity, and that which the plant is capable of under special circumstances. And each can rightly be termed the plant capacity.

For the UK, the figures reported here are the best estimates available, those supplied by the Petroleum Information Bureau (London). These put the country total for December 31, 1958, at 720,400 b/d (36,020,000 long tons per year), and full details of individual plants and special processing facilities are given in the section "Oil Refineries of the World" elsewhere in this issue.

Since the end of the year, however, two new major crude distillation units have come onstream, with the result that Shell Haven refining capacity has risen to 160,000 b/d from 80,000 b/d, and that of Grangemouth to 64,000 b/d from 44,000 b/d. Coryton distillation capacity has also been raised about 20%. On this basis, the UK current (June 30, 1959) refining capacity has been raised appreciably to 828,200 b/d (41,410,000 tons per year) and the details for individual plants are shown in Table II.

While Shell maintains its position as the largest crude oil refiner, the margin with British Petroleum has been narrowed appreciably since the bringing in of these units. The position in regard to share of ownership in this capacity is shown in Table III.

Recently completed and current project developments at individual refineries will now be reviewed briefly.

At Shell Haven, the second crude distillation unit brought in by Shell Refining Co. with a capacity of 80,000 b/d of Middle East crude and costing about £6½ million with all ancilliary equipment, was stated to raise total refinery capacity to 8,000,000 tons a year, and the total "Shell" capacity in the UK to some 15,000,000.

This new unit has two special features. A high degree of heat recovery is employed, with the result that fuel consumption in its operation was expected to be some 30% less than in the first unit. The second outstanding feature is the high recovery of light hydrocarbons; this results from the use of a large high-speed centrifugal compressor, which receives all the uncondensed streams and delivers them to the gas fractionating columns. The furnace employed in the new unit is stated to be the largest of its kind in any Shell refinery in the UK.

Another recent Shell Refining Co. development is the bringing in at Stanlow of a 1,000 t/d Udex unit for producing an improved aviation gasoline blending component from a feed stock based on the Platformer. The unit, which cost about £800,000 was designed by Universal Oil Products Co. and is the first of its kind in any Shell refinery; it is of the solvent-extraction type, using a special mixture of di-ethylene glycol, dipropylene glycol, and water.

Currently under construction at Shell Haven is a Hydrodesulfurizer. This will remove sulfur from gas oil feed stock to augment the supply of high-speed diesel fuel, using the Shell "trickle-phase" process successfully applied in many other refineries. The cost of this unit, with ancilliaries, is put at £2.2 million, and it is expected to be in operation by the last quarter of this year. Some 20 tons a day of pure liquid sulfur will be made by converting the recovered sulfur impurities into hydrogen sulfide by the aid of hydrogen from a Platformer.

Following the recent agreement between Shell Refining Co. and the North Western Gas Board, plans are in hand to construct a 200 t/d plant, costing about £160,000 for treating refinery gas to low sulfur content, thus making it suitable feed stock for processes operated by the gas board for conversion to use as town gas. This unit has been designed with surplus capacity to allow for increase in offtake, should this be required.

To pass now to British Petroleum Co. developments: The second new crude distillation plant brought in this year so far is the 24,000 b/d unit of BP Refining (Grangemouth) Ltd. This was stated to make the end of the first stage of a £6 million development program to raise Grangemouth crude capacity to 3.2 million tons a year from 2.2 million. Other new units stated in February to be in the course of commissioning included a de-ethanizer for improving the quality of propane gas, a copper chloride unit for sweetening gasoline, and gas oil and kerosine treating units. Thirty-seven new storage tanks have been erected; a new boiler for raising 150,000 lb/hr of steam has been commissioned; and a 2,250 kw electric generator driven by an experimental gas turbine was being installed.

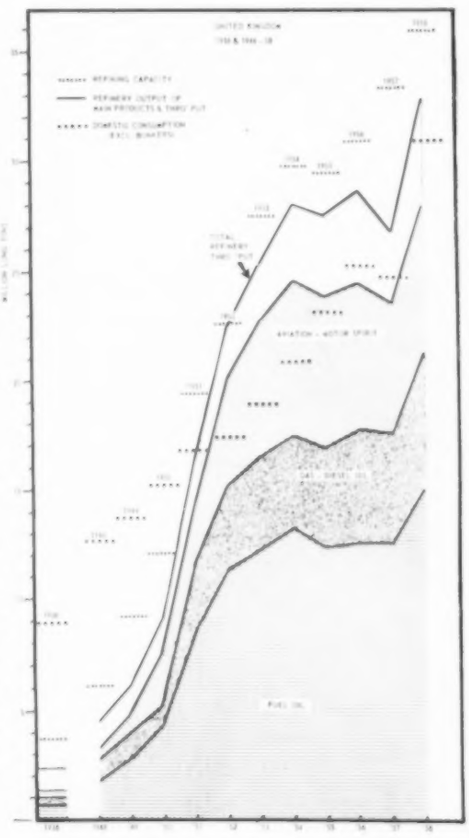
Another recent BP plant completion to be recorded is that of BP Refining (Kent) Ltd., where towards the end of 1958 a 12,000 b/d thermal reformer built by Kellogg was placed onstream. This is designed for treating either light or heavy naphtha fractions from Middle East crudes to produce a debutanized reformate of maximum octane (research) rating. The unit is also capable of handling platformates of similar boiling ranges. An interesting point about this unit is that at least 2,000 hours' continuous operation was regarded as an essential design requirement; and, in order to implement this, two 6,000 b/d reforming furnaces were provided.

In December a 10,000 b/d catalytic reformer, built by Kellogg to a Universal Oil Products' design, was commissioned. This is producing high grade motor and aviation spirit components. The reformer is the last of the 21 new units installed at the Kent refinery over the past two years to be commissioned, and the plant now has a capacity of 7,100,000 tons a year as compared with the previous 4,600,000.

There has not been any work on new plants at either BP's Llandarcy or Pumpherston refinery during the past six months.

It is worth recording that both British Petroleum and Shell have an interest in the 2,000,000-ton-per-year refinery which has just come into operation at Whitegate (Cork), Ireland, through the 40% share held by Shell-Mex and BP Ltd. This new plant is the subject of an article elsewhere in this issue. Esso Petroleum holds a similar share and the Caltex group 20%. The important point is that Irish annual consumption being only of the order of a million tons, there will be roughly this amount available for export.

Esso Petroleum Co. Ltd. has completed two major projects at the Fawley refinery in recent months, apart from the chemicals plant which is the subject of a separate article in this review. These are (a) a Powerformer to meet the increased demand for high-octane motor gasoline, equipped



A tight squeeze for 90-ft column built by Rustons' boiler division to the order of Foster Wheeler Ltd.

with facilities for onstream catalyst regeneration and integrated with a hydrofiner to provide desulfurized feed, and (b) a naphtha stabilizer to increase stabilizing capacity in step with a growing crude run.

To provide the necessary marine terminal facilities for this expansion, a fifth ocean berth has been commissioned. Thus the 4,500-ft jetty is now capable of handling five ocean-going tankers and four coasters at the same time. Five units of the latest hose-handling equipment have been installed to Esso specification by Foster Wheeler Ltd. in conjunction with Woodfield Rochester Ltd. Hoists and winches are powered by Holman reversing-air motors remotely controlled by Maxam pneumatic equipment—a development of great interest to the oil industry, as it is demonstrating the versatility of compressed air and the efficiency resulting from its use. The heavy hoses are handled and accurately positioned for coupling and adjustment for ship movement or tide change by the Maxam equipment from a one-man control panel on the jetty.

TABLE I—UK REFINERY OUTPUT

(1,000 Long Tons and Per Cent)

Product	1958	1957	1956
Motor and aviation spirits	5,750.7 (20.5%)	5,908.2 (21.2%)	6,771.2 (23.6%)
Industrial and white spirits	144.4 (0.4%)	140.6 (0.6%)	136.2 (0.5%)
Kerosine	1,292.0 (3.9%)	839.5 (3.1%)	869.3 (3.0%)
Lubricating oil	751.4 (2.3%)	742.9 (2.6%)	776.4 (2.7%)
Gas-diesel oil	6,284.7 (19.1%)	5,066.5 (18.2%)	5,188.8 (18.1%)
Fuel oil	12,572.3 (38.2%)	10,466.6 (37.6%)	10,394.8 (36.2%)
Refinery fuel consumption*	2,503.4 (7.6%)	2,091.0 (7.5%)	2,130.9 (7.4%)
Bitumen	859.5 (2.6%)	812.8 (2.9%)	933.4 (3.3%)
Other products and loss	1,774.8 (5.4%)	1,750.3 (6.3%)	1,480.3 (5.2%)
Total	32,933.2	27,818.4	28,681.3
Deliveries into consumption (Excl. foreign bunkers)	31,065.6	24,784.6	25,223.1

* Excl. own production

At Milford Haven in Pembrokeshire (Wales), where Esso is building an £18 million refinery on 350 acres of a 1,000-acre property to process initially 4½ million tons of Middle East crude a year, good progress is reported. All work is up to schedule, in line with the completion date set for November 1960. The main contractors here are Foster Wheeler Ltd., Motherwell Bridge & Engineering Co., Whessoe Ltd., and Geo. Winnipeg & Co.

The refinery has been carefully planned to fit as far as possible to a natural "bowl" so that its intrusion into an essentially rural district shall be minimized, and the grading has accentuated this careful use of contours. The vast network of main underground sewers, drainage, and services is now almost complete; and work started on the process units at the end of June. Erection is in hand of the primary distillation unit, and foundation work is well in hand for the other units.

The greatest portion of the base groundwork to date has concerned tankage, and 30 of the 60 to be erected are completed or building. Of the permanent buildings erected, the 340-ft by 140-ft engineering workshop dominates the scene. Already fully equipped, it is helping refinery construction by turning out fabricated pipe lengths and fittings, etc. Construction of the civil buildings has started; these will include a demonstration building, canteen, medical block, and laboratory.

The marine-terminal contractor is well advanced in casting and driving the hollow cylindrical prestressed concrete piles up to 130 ft long and weighing 15 tons, and piling is proceeding in the deep water of the Haven and along the approach-jetty from the shore to the tanker berths.

Mobil Oil Co.'s major project of recent months has been the bringing in of a new LP Gas plant, described elsewhere in this review; but additions and modifications to the 2-stage crude distillation unit recently completed have raised its capacity by some 20%. By revamping the furnaces and additions to the heat-exchanger equipment, it is now capable of handling 1.85 million tons a year continuously and up to a 2.25 million tons over peak periods.

This month (July) sees the start of an agreement to supply at least 2 million cu ft per day of Coryton refinery gas to the North Thames Gas Board. This is equivalent to the amount of gas from 120,000 tons of carbonization coal a year, and the agreement is initially for 10 years.

No major development at its Ellesmere Port refinery has been reported by Lobitos Oilfields Ltd. since the sulfonation plant was commissioned last year. Under the heading of "ancilliaries," however, may be mentioned the recent installation of improved facilities for dehydrating transformer oil prior to dispatch and also for packaging this and other electrical oils. A completely new control and testing laboratory was expected to be in operation by the time this review is published.

From Manchester Oil Refinery Ltd. comes news of continued expansion of the plant for producing specialized petroleum derivations. Although the new oil-soluble sulfonates plant was only commissioned in January 1958, it was further extended at the end of the year and now has an output of over 3,000 tons a year of a wide range of commercial sulfonates. Still further expansion is planned for 1959, when the use of anhydrous SO_3 as a sulfonation agent will be extended to operations until now carried out with 20% oleum.

The company installed its first electricity induction generator/back-pressure steam engine set in 1946. This worked on 300-lb steam exhausted at 150 psi for process use, and up to 20% of refinery electricity requirements were so generated at very low cost. A new Babcock & Wilcox boiler of 60,000 lb/hr nominal capacity was commissioned at the end of 1958, and this opportunity was taken to raise steam pressure to 600 psi so as to enable a pass-out steam turbine to be installed capable of driving a generator adequate to supply all refinery electricity requirements. Other recent developments include the erection of an additional 85,000-bbl crude storage tank and a number of new tanks for lubricating oil storage with capacities up to 15,000 bbl.

"Finis" has been written to Chapter I of the story of the long-mooted proposal—since 1950, in fact—by *Caltex (UK) Ltd.* to erect a 5 million ton refinery at a cost put some years ago at £25 million on Southampton Water. Such opposition was engendered by yachting, agricultural and other interests that the government, which has approved

the project in principle, ordered a public inquiry to be held so that all viewpoints could be presented and considered officially.

Early in May, almost on the eve of this inquiry, the company announced the withdrawal of its application for official planning permission on the grounds that "after re-examining its refinery capacity requirements it was unable to announce at the inquiry a definite date for construction of the proposed refinery . . . when the company is in a position to put forward a firm and reasonably imminent date for the construction of a UK refinery, it will resubmit its proposals." Chapter II may well be a long time in opening.

Reports were current toward the end of last year that *Tidewater Oil Co. (England) Ltd.* was considering building a refinery at Tynemouth, County Durham. It can now be said with authority that Tidewater has no such project in hand.

On the other hand, it has recently been made known that *Shell-Mex and BP Ltd.* is willing in principle to build and operate a refinery in Northern Ireland, subject to satisfactory conditions being negotiated with the Ministry of Commerce and other interested parties. There are no refineries at present in Northern Ireland.

No projects are in hand at the Dundee refinery of *Wm. Briggs & Sons Ltd.*, and WORLD PETROLEUM is informed none are anticipated.

One of the smaller UK specialty plants has been in the news recently. This is the Renfrew refinery of *J. O. Buchanan & Co. Ltd.*, whose principal products are white oils and transformer oils. White oil refining only commenced in 1955, following the rebuilding of the original works in 1932 after complete destruction by fire in 1952. Tankage has recently been increased appreciably, and a new policy instituted of importing partly processed crude by coastal tanker instead of by road-tank vehicle. Plant capacity is only 8,750 tons a year, but the important point is that the company expects the change to lead to further expansion in the near future.

As to *Berry Wiggins & Co. Ltd.*, following the reorganization carried out at the Kingsworth (Kent) refinery in 1954, improvements in layout have been made at the Weaste (Lancashire) plant, together with the erection of a new 100,000-ton-per-year 2-stage distillation unit which was brought onstream in the second half of 1958. This replaced an earlier unit, now being dismantled, and is witness to the fact that even the smaller UK refineries are being modernized in keeping with today's requirements for economic processing, as shown by the following description of the new Weaste unit.

Embodying atmospheric and vacuum distillation stages, the design features provide for great flexibility in operation, making the fullest use of instrumentation and automatic control and, because of special site conditions, incorporates many special features in the arrangement of the sections and in layout and engineering.

The primary end product is high grade steam-distilled bitumen in wide penetration range, and the main side stream products include gasoline, kerosine, gas oil.

Atmosphere Stage—The crude charge, after heat exchange with side streams and overheads, is fed to an atmospheric tube still of the vertical upshot type. The partly vaporized crude is then admitted to an atmospheric distillation column and stripping stream, superheated in the atmospheric tube still, is injected at the base of this column which has conventional bubble-cap type trays. The overhead product (gasoline) after condensation passes through a continuous pretreatment (caustic-wash) stage and a final treatment to give a sweet product. The side stream products (kerosine and light gas oil) pass through steam stripping columns before cooling.

Vacuum Stage—Reduced crude from the base of the atmospheric column, after further heating in the vacuum tube still, passes to a vacuum distillation column with bubble cap trays above the feed and disc and donut stripping trays below. Vacuum is maintained by a 2-stage steam jet ejector, and stripping steam is injected into the base after superheating in the vacuum tube still. The cooled overhead product (heavy gas oil) and the light gas oil from the atmospheric stage are then. combined and pass to a steam stripping column, the stripped gas oil leaving the base being cooled by the ingoing heavy gas oil. The lubricating oils which form the three side streams, which can be varied considerably in specification and yield, are steam-stripped under vacuum, cooled, and treated in existing facilities external to the No. 3 unit, while the bottom product is a high grade bitumen with penetrations capable of wide variation according to operating conditions.

Tube Still, Atmospheric Stage—This is of the vertical upshot type designed to operate under forced-draft conditions, with a main heating element of 21-ft-long tubes connected by cast return headers and a superheating element in the upper reduced section of the tube still consisting of a welded tube bundle.

Tube Still, Vacuum Stage—This is also of the vertical upshot type but designed to operate under natural draft conditions. The dimensions (overall height 36 ft excluding flue to the common stack and diameter 10 ft), and internal arrangements are similar to the atmospheric tube still. The design chosen after close study of the effect of tube diameter on pressure and temperature distribution throughout the still was considered likely to reduce to a minimum the possible incidence of temperature "peaks" and the associated adverse effects of thermally cracking a reduced crude and localized corrosion.

Columns, Atmospheric Stage—The distillation column (overall height, including skirt, 90 ft., and diameter 3 ft 6 in.) is a mild-steel shell fitted with cast iron bubble-cap trays, and the two stripping columns are of similar construction.

Columns, Vacuum Stage—The column shell (overall height, including skirt, 84-ft, and diameter 7 ft. 6 in.) is of mild-steel plate internally clad with 13% chrome steel because of the corrosive nature of the crude under vacuum. The cast iron stripping trays fitted above the feed are of the conventional bubble cap type, while below the feed there are alternate disc and donut types. The three vacuum steam stripping columns (height 15 ft and diameter 2 ft.) are similar in design to the atmospheric steam stripping columns.

Other Equipment—With the exception of the bitumen/crude heat exchanger, which is of a special type as used in the company's Kingsnorth refinery, the heat exchange equipment is of the conventional shell-and-tube type. All pumps are steam driven double acting duplex, but with enlarged cylinders because of the relatively low steam pressure available. The vacuum ejector is of the 2-stage steam jet type, and the condensers are surface type to prevent contamination of the closed cooling-tower water system. New boilers with Wallsend oil burning equipment and cope's automatic feed water regulators have been installed to meet the increased high-pressure steam requirements, and additional cooling towers to meet the higher condensing requirements.

Finally, in Berry Wiggins & Co.'s new Weaste refinery, very extensive use of instrumentation has been made in every section of the plant; and many of these, where applicable, are of the pneumatic type.

TABLE II

ANNUAL CAPACITY OF UK REFINERIES (LONG TONS)

(as at June 30, 1959)

Shell Petroleum Co.	
Shell Haven	8,000,000
Stanlow	5,000,000
Heysham	1,800,000
Ardrossan	160,000
	14,960,000
British Petroleum Co.	
Kent	7,100,000
Grangemouth	3,200,000
Llandarcy	3,000,000
Pumpherston	180,000
	13,480,000
Esso Petroleum Co.	
Fawley	10,500,000
Mobil Oil Co.	
Coryton	1,850,000
Lobitos Oilfields	
Ellesmere Port	210,000
Manchester Oil Refinery	
Trafford Park	175,000
Berry Wiggins & Co.	
Kingsnorth	100,000
Weaste	100,000
	200,000
Briggs, W. & Sons	
Dundee	35,000
Total	41,410,000

	British and British/Dutch	United States
June 30, 1959	70.2	29.8
December 31, 1958	66.7	33.3
December 31, 1957	63.4	36.6

Heaters for the Bordeaux Refinery, Esso Standard Francaise, were designed in such a manner that the stack gases from all of the heaters could be collected and exhausted to the atmosphere in a common stack having a minimum height of 60 meters with a view towards meeting the French regulations regarding air pollution in the Bordeaux area.

New "grass roots" refinery adds 31,500 barrels to French capacity

by V. Severs

Soil conditions at Garrone River site causing undue settling presented problems in tankage erection on hydraulic fill.

VICTOR SEVERS, project manager for the Esso-Bordeaux refinery, has been engaged in project engineering and project management for The Lummus Co. since 1935. He was graduated from M.I.T. in 1927 and entered the petroleum industry in 1929 as a field construction engineer for E. B. Badger & Sons Co. In 1931 he joined Atlantic Refining Co. at its Eclipse Works at Franklin, Pa., where he remained until he joined Lummus in September 1935.

FRANCE'S refinery capacity was increased 31,500 barrels per calendar day when the new Bordeaux Refinery of Esso Standard France was put into complete operation, late in April 1959 at Ambés (Gironde).

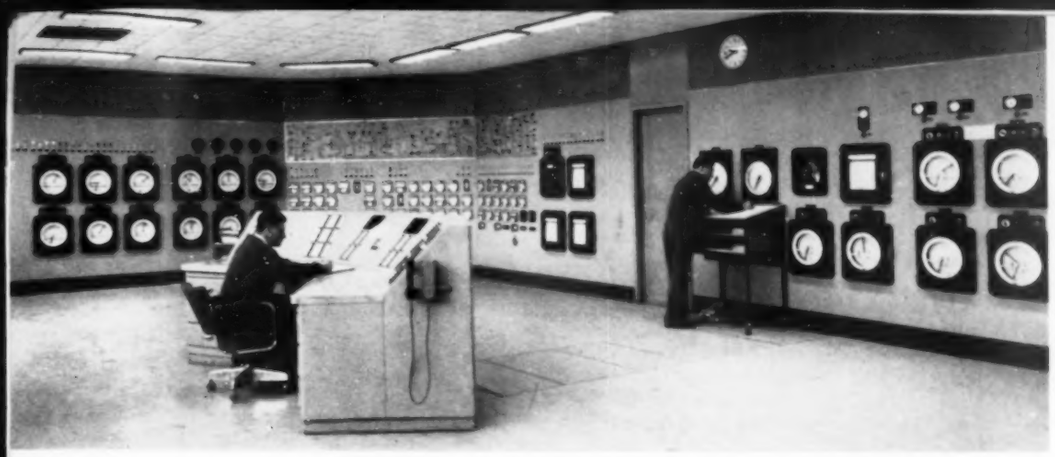
While there has been considerable expansion of previously existing refineries in France, this is only the second "grass roots" refinery to be built in France since World War II.[1] In addition, it is the first one to be designed and built to operate on French crude as one of its major feed stocks. This crude is supplied by a 12" pipeline from the Parentis field South of Bordeaux which was brought into production by Esso-REP several years ago.

Although the refinery will operate initially at 31,550 b/cd all of the facilities have been designed to permit expansion at minimum cost to a crude throughput of 45,800 b/cd. Essentially, the modifications required to permit this expansion consist of the addition of storage tanks, minor alterations to the atmospheric and vacuum fractionating columns in the process units and additional boiler feed water treating equipment.

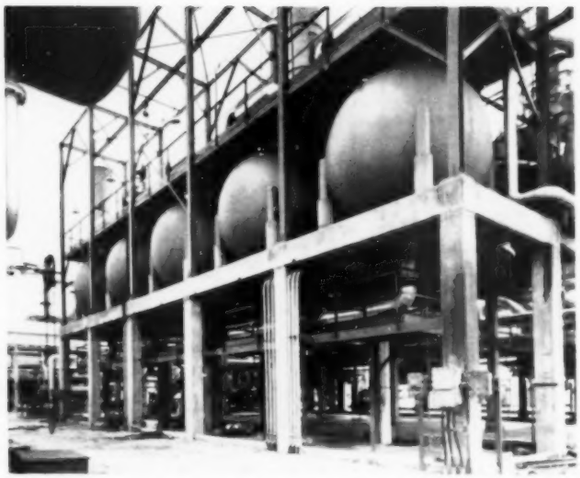
The refinery design follows the general pattern of a number of new refineries presently being designed and built in Europe by affiliates of Standard Oil Co. (N.J.). This, of course, is only true with respect to the processing sections. Administration and other general buildings, shop and warehouse buildings, crude supply, product loading and utilities vary to suit the needs of and location of the particular refinery.

In common with the others being built, the processing scheme is relatively simple. It consists of atmospheric and vacuum distillation, with hydrofining and Powerforming to produce the required gasolines. Light

[1] The first went on stream in 1952 for Societe Generale des Huiles de Petrole at Dunkirk. It too was designed, engineered and constructed by Lummus.



The control room and panel which is equipped with circular recording and control instruments as well as a full graphic panel of the refinery's operations.



Shown above are the five spherical reactors of the Powerforming unit used to catalytically reform the heavy naphtha produced in the crude distillation unit.

The crude atmospheric and vacuum distillation units shown right have been designed to operate on a variety of crudes. Primary supply now is from the nearby Parentis field.

ends and treating sections are also included for both the pipe still and Powerformer. This processing scheme has been defined in Esso Research and Engineering Co. published literature as "Hydro-Skimming."

The Refinery is designed to produce LP-Gas motor gasolines, jet fuels, kerosine, diesel fuels, heating oils, light and heavy fuel oil, and asphalts. Automatic blending equipment has been provided to produce the various grades of asphalt required for the French market.

Due to the location of this refinery, the facilities for bringing in crude oil and shipping out products are quite extensive. As previously mentioned, French crude is delivered to the storage tanks through a 12" pipe line from the Parentis field. Other crudes, if required to meet the overall refinery commitments for finished products, can be delivered through a 16" pipeline from the Docks des Pétroles d'Ambés where tanker shipments can be received. This line is tied into the 12" Parentis pipeline and the fuel oil loading system, which permits the transfer of crude and fuel oil to the dock for tanker shipments out. The dual service for this pipeline, handling both crude and hot fuel oil, presented problems which will be discussed later in this article. In addition to the 16" line, two 4" pipelines have been provided to ship propane and butane to the COBOGAZ bottling plant in the near vicinity and a 12" pipeline to ship fuel oil to other points in the area.

Complete facilities to ship products by coastal tankers, barges, tank cars and tank trucks, including a separate tank truck loading rack for asphalts, have been provided.

In addition to product shipping, it was, of course, necessary to provide complete auxiliary and off-site facilities which include storage tanks, steam generation, cooling water, electric power, and air together with necessary piping, transfer pumping and TEL blending.

The outdoor type steam boiler plant is designed to meet process, steam tracing, tank heating requirements and a minimum requirement for driving mechanical equipment. Steam drives are used in the boiler plant to maintain steam during a power interruption and to furnish exhaust steam for the deaerating feed water heater. The other principal users are the spare cooling water circulating pump and the spare air compressor.

Electric power is brought into the main sub-station at 63,000 volts from Electricité de France (EDF) and reduced to the required operating voltage within the refinery.

Water is supplied from deep wells (approximately 275 meters deep) for cooling tower makeup, process, boiler feed, domestic and sanitary uses. The wells also provide

a partial reserve for fire protection. They supply water for an electric motor-driven fire pump located in the cooling tower pump basin. The balance of the requirement for fire conditions is supplied by a second diesel engine driven fire pump located at the barge and coaster dock. This pump takes its water supply from the Garonne river and feeds the general fire protection water system.

The Lummus Co. through its French subsidiary, Société Francaise des Techniques Lummus, was selected by Esso Research and Engineering Co. in July 1956 to prepare detailed job specifications for the design of the Bordeaux Refinery. A group was assembled to take care of this assignment which included the bringing in of a certain number of specialists from the Lummus New York Office to combine with specialists already in the Paris Office to complete the group for this first assignment. To supervise and insure that the detailed job specifications were complete in all details with respect to Esso Research and Engineering standards and also the owner's requirements, a team of process and mechanical specialists were assigned by Esso Research and Engineering to the SFTL offices in Paris.

This phase of the work was organized and the detailed preparation of the job specifications were started in September 1956. While this work was developing, the Lummus Co., through its French subsidiary, was also selected by Esso Standard France, and Esso Research and Engineering, to undertake the detailed engineering design, procurement engineering, expediting and management of construction for the Bordeaux refinery. The purchasing and inspection services were performed by Esso Standard France.

While the job specifications were being completed, a separate team was organized by Esso Standard France, Esso Engineering and SFTL to carry out the purchase of materials and detailed engineering for the refinery. In general, it was possible to shift engineers within SFTL from the job specification work to the execution of the final designs. In a number of cases, it was also possible to continue this into actual field construction work. This continuing familiarity contributed greatly to the execution of the whole project.

Requisitioning of critical materials and equipment began in February 1957. The present manufacturing and fabrication facilities in France are such that it was possible to purchase nearly all materials and equipment in France, including miniature instruments for the main control room panel board. For the complete refinery, in all classes of materials and equipment it was necessary to go outside of France for special purchases, but only for a very small percentage of the total material.

Detailed design work in the drafting room was started during April 1957, and was essentially complete by the end of July 1958. The only special design problems encountered, worthy of note, were the 16" pipeline and provisions for unusual flexibility in piping around the storage tanks because of anticipated settlement due to soil characteristics.

A 16" pipeline, approximately three miles in length, was required to transfer fuel oil and also Parentis crude to the Docks des Pétroles d'Ambés for tanker shipments. Since the line ran through cultivated land during part of its run and close to a public highway during other parts, it had to be installed as a buried line on a minimum width right-of-way. Fuel oil transfers at the required pumping temperature of 190°F presented a different expansion problem. Various possible methods for taking care of this expansion were studied including expansion loops coming out of the ground. Because of right-of-way restrictions, the consideration of expansion loops had to be abandoned. Finally a slip type expansion joint was selected and used.

Soil reports for the site indicated that during early operations tankage settlements of six to eight inches or more could be immediately anticipated with operating liquid loads. Eventual settlements of several feet were anticipated before final soil consolidation under the tanks could be achieved. This total consolidation was predicted over a long period.

With this known problem of tankage settlement, flexibility was designed into the tankage piping to permit settlement. It was assumed as a design premise that the refinery would raise the tanks when the allowed settlement had been reached. Also, because of this problem, construction of the tankage was given a priority beyond what would normally have been planned in order to achieve the anticipated initial soil consolidation by water loading of the tanks before the refinery went into operation.

When the water loading of the tanks was started in accordance with previous planning, it was found that the initial rates of settlement were such that the water loading had to be frequently discontinued because of cone bottom reversals which endangered the first course shell ring of the tanks.

Various methods of packing and jacking were tried. The final solution to the cone bottom problem was found with the use of "Intrusion Prepakt." With this method, it was possible to reverse the coned bottom of the tanks as the grout was injected. The program as carried out with the use of this method permitted the tankage to be made available for operation.

A brief description of "Intrusion Prepakt" and its application to the tankage problem at Bordeaux is of interest.

The Intrusion Prepakt Co. of Chicago, Ill., developed equipment and an "Intrusion Aid" which permitted them to pump a Portland cement grout under pressure. Portland cement grout pumped by this method has numerous applications including the underpinning of concrete foundations and concrete slabs. The application for the underpinning of foundations and slabs led to the consideration and trial of "Intrusion Prepakt" as a solution for the tank packing problem.

After the decision had been made to try this method of packing under the tank bottoms and restoring them to their original position, equipment and operating crews were brought in from the company's European office in Madrid, Spain. The first trials of the method indicated that with grout injection holes installed in the bottom of the tanks, grout could be successfully injected and the bottoms restored. After the operation had been completed the grout injection holes were sealed off in such a manner that the tanks could be water loaded again and the grout injection holes reused if further packing was required. Where it was also necessary to jack up a tank, the edges were filled in and sealed off before the grout was injected.

Plans for the refinery included raising the grade approximately five feet at the front along the Garonne river sloping to two and one half feet in the back area using hydraulic fill. Deposition of the hydraulic fill started late in April 1957 and was completed by October 1, 1957.

Construction personnel from Lummus and Esso Engineering arrived at the job site early in May 1957 to prepare for actual construction because it was necessary to install temporary facilities and start construction work before the hydraulic fill was completed and had an opportunity to drain, in order to meet the scheduled completion date. Site drainage was a continuing problem until early in the summer of 1958 when the work got out of the ground. All excavation for underground piping and sewers required wood sheet piling for the trenches, and in a number of instances it was necessary to put concrete collars on the steel pipe to sink it into position and keep the pipe from floating until the trenches could be backfilled.

Construction was carried out almost entirely by sub-contract, using the following contractors for the major portion of the work:

Société des Travaux de Montagne for casting and driving concrete piling.

Société Générale d'Entreprises for the Barge and Coaster Dock, civil work, and offsite electrical work.

Etablissements Ponticelli Fréres for underground piping and general erection of the process units.

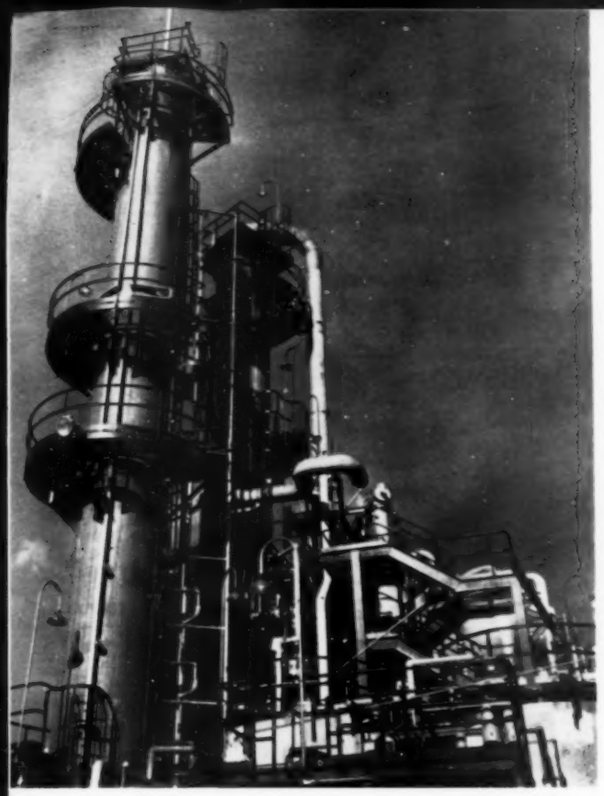
Compagnie Industrielle des Travaux for general erection of offsites.

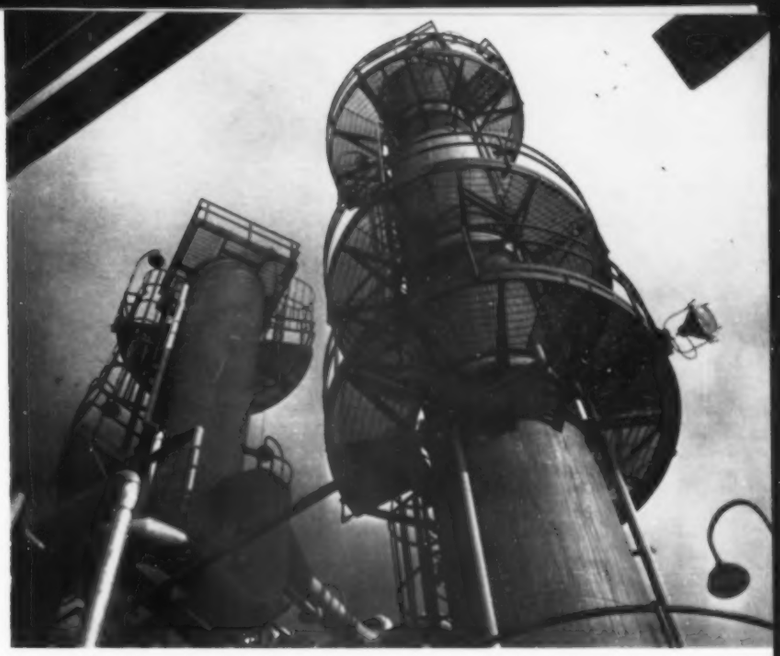
Grands Travaux d'Electrification et Canalisations for electrical work in the process units.

Comsip Automation for instrument work.

During January, February and March 1959 the various component parts of the refinery were turned over to Esso Standard for operation.

Ambés has now taken on a distinct industrial appearance with the refinery, and a large new electrical generating station nearing completion for Electricité de France, added to the Caltex refinery and a gas bottling plant already located in the area.





Top of fractionation column at National Aniline's adipic-acid plant: Adipic acid is a key intermediate in the production of nylon-66.

Fractionation and reaction section in an adipic-acid plant (courtesy National Aniline Division).

Petrochemical raw materials for nylon resins: Part I

by Peter W. Sherwood*

NYLON is the generic name for a group of polyamides employed in the production of synthetic fibers and plastics. Two types of nylon make up almost the entire market: nylon-66, which is essentially a copolymer of adipic acid and hexamethylene diamine; and nylon-6 (polyaminocaproic acid), which is formed by polymerization of caprolactam. The greater part of all three raw materials is derived from petrochemical operations. A third type of nylon (6 10) is based on hexamethylenediamine and sebacic acid, the latter mainly a derivative of castor oil (but also obtained from butadiene as byproduct in isosebacic-acid synthesis).

Nylon-66 was first produced commercially in 1939 (at Seaford, Del.), but its main growth period did not begin until the end of World War II. Output rose from 25 million pounds in 1945 to 210 million pounds in 1954, the year when nylon-6 first appeared on the American market. Since then, nylon-6 has made strong competitive inroads, though nylon-66 remains by far the dominant factor in the field. In 1958, fast-growing nylon-6 accounted for 10% of the market, with almost 90% still covered by the hexamethylenediamine-adipic acid copolymer (nylon-66).

*Chemical Engineer, White Plains, N.Y.

Synthetic fibers and plastics constitute the end-use areas for both types of nylon. Fiber production is by far the more important of the two markets. Output of nylon fiber in 1958 has been estimated at 360 million pounds. Nylon consumption for molded plastics and for bristles was 20 million to 25 million pounds during the same year.

A good growth is anticipated for nylon in both of its end use areas. Output of nylon plastics (exclusive of bristles) has been forecast at 45 million pounds in 1963, with the greatest spurt shown by extruded products. Outlook for nylon fiber is 450 million pounds in 1963, 500 million pounds in 1965.

Following a major construction program during 1957-58, polymerization capacity for nylon manufacture is about 15% ahead of output, and is adequate for production requirements through 1961. Total USA plant capacity for nylon was rated at 450 million pounds per year in late 1958. This is an increase of nearly 100 million pounds per year over plant rating in early 1957.

Announcements of additional capacity may be expected in the near future as the field becomes increasingly competitive. Prior to 1954, there was only one nylon producer (DuPont) in the United States. Today there are 12 manufacturers of nylon fibers and four producers of nylon plastics. As of early 1959, the line-up of nylon manufacturers in the USA is as shown in Table I on following page.

It is interesting to note that most of the new entrants have concentrated their effort on nylon-6. There are several reasons for this. First, it represented a new entry into the American market, which could be counted on to compete more effectively with DuPont and Chemstrand, the established producers of nylon-66, and the largest factors in the business. Second, nylon-6 is potentially a less expensive product than nylon-66 due to a more favorable raw-materials position.

Other factors of importance are availability of foreign know-how for production of nylon-6 and differences in the physical properties of the two grades of nylon. Although nylon-6 has a somewhat lower melting point than the 66 polyamide, nylon-6 textiles are somewhat softer in feel and have a slightly better affinity for dyes and greater abrasion resistance.

Raw-Materials Position: Three intermediates constitute the bulk of raw material in nylon production: adipic acid and hexamethylene diamine for nylon-66 and caprolactam for nylon-6. All three can be and are produced by various routes; in all three, production from petroleum-derived

TABLE I

Company	Nylon Type	Plant Location
A. Synthetic Fibers		
Allied Chemical Corp. (National Aniline Division)	6	Chesterfield, Va.
American Enka Corp.	6	Enka, N. C.
Chemstrand Corp.	66	Pensacola, Fla.
Dawbarn Brothers Inc.*	66	Waynesboro, Va.
E. I. duPont de Nemours & Co.	66	Seaford, Del. Chattanooga, Tenn. Martinsville, Va. Richmond, Va.
Firestone Plastics Co.*	6 and 66	Pottstown, Pa.
Industrial Rayon Corp.	6	Covington, Va.
National Plastics Products Co.*	66	Odenton, Md.
North American Rayon Corp.	6 and 66	Elizabethton, Tenn. (pilot plant)
Poliafil Inc.*	66	Scranton, Pa.
Polyarns Inc.	?	Canandaigra, Pa.
Polymers Inc.*	66	Middlebury, Vt.
B. Plastics		
Allied Chemical Corp. (National Aniline Division)	6	Chesterfield, Va.
E. I. duPont de Nemours & Co.	6, 66, 6/10	Parkersburg, W. Va.
Foster Grant Co.	6	Leominster, Mass.
Spencer Chemical Co.	6	Henderson, Ky.

*Not a primary nylon resin producer.

chemicals is rapidly assuming the dominant role. The remainder of this article will be devoted to a discussion, first of the economic and supply situation pertaining to these petrochemical nylon intermediates, and finally to a consideration of the technology of their manufacture from petroleum sources.

I. Economic Factors—

Adipic acid figures in the nylon picture in a dual role. It is not only one of the monomers for nylon-66, but is also an intermediate in one route to hexamethylenediamine, the other monomer.

USA consumption of adipic acid has risen from an estimated 190 million pounds in 1954 to some 325 million pounds in 1958. About 85% of consumption is accounted for by nylon synthesis. Slightly more than 10% of adipic-acid output finds its outlet in the production of adipate plasticizers, while another 3% goes into the manufacture of polyurethanes.

Neither plasticizers nor polyurethanes, however, offer a promising market outlook for adipic acid. In both areas, competitive materials exert strong competitive pressure. Adipic-acid consumption in plasticizers has been nearly level for the past 10 years, while a switch from polyester foams to polyether foams dims the once-bright outlook for adipic acid in polyurethanes. The future of adipic acid, therefore, continues to be tied to the expected growth in nylon-66 (and, to some extent, in nylon 6/10).

USA plant capacity today is estimated near 400 million pounds per year of adipic acid. Originally, benzene was the chief raw material; but today the emphasis in American practice has clearly shifted toward a cyclohexane base. Following is the line-up of USA adipic-acid manufacturers:

Manufacturer and Plant Location	Raw Material
Chemstrand, Pensacola, Fla.	Cyclohexane
DuPont, Belle, W. Va., and Orange, Texas	Cyclohexane and some benzene
National Aniline, Hopewell, Va.	Benzene (via phenol)
Monsanto, Luling, La.	Cyclohexane

Hexamethylenediamine, the second monomer for nylon-66, is poduced commercially by the hydrogenation of adiponitrile. Two major routes are used to make this intermediate nitrile from petroleum raw materials. In one of these, adipic acid and ammonia are the raw materials. In the other, butadiene and hydrogen cyanide are the petrochemical base stocks. A third route, starting from furfural (derived from oat hulls) is taken by DuPont at Niagara Falls, N. Y.

Nylon-66 (and, to a much lesser extent, nylon 6/10) are in essence, the only important markets for hexamethylenediamine. Average consumption is reported at 0.554 lb. HMDA per pound nylon-66. Total 1958 demand for hexamethylenediamine may thus be estimated at 185 million to 190 million pounds.

Key to hexamethylenediamine economics is the route selected to its final intermediate, adiponitrile. Of the four petrochemical adiponitrile plants, one (DuPont at Victoria, Texas) employs butadiene as raw material. The other three (DuPont at Orange, Texas, and Belle, W. Va.; and Chemstrand at Pensacola, Fla.) employ the adipic-acid route to adiponitrile.

ε-Caprolactam is the only monomer in the production of nylon-6. This is one of the newer petrochemicals on the American scene. Large-scale demand for it coincided with startup of the first nylon-6 polymerization facilities in 1954.

Initial demand for caprolactam was met by relatively small facilities of Olin Mathieson at Morgantown, W. Va., and of National Aniline Division at Hopewell, Va. In addition, imports were received from Germany where nylon-6 has long been produced under the tradename "Perlon."

A major expansion project has since made National Aniline Division the largest caprolactam producer. Capacity as of January 1, 1959, was reported at 60 million pounds per year. One other large entry into the caprolactam field has been announced recently by DuPont which expects to begin operation of a 50-million-pound-per-year unit at Beaumont, Texas, in late 1960.

Recently scrapped were the plans for a 20-million-pound-per-year caprolactam plant announced by Ohio River Chemical Co. (Ashland, Ky.), a joint subsidiary of Spencer Chemical and Industrial Rayon. Still indefinite are Commercial Solvents Corp.'s (Peoria, Ill.) plans for a small caprolactam unit.

All told, caprolactam capacity is now more than adequate to meet demand. Typical consumption rate is 1.1 lb caprolactam per pound nylon-6. On this basis, prospective requirements for the lactam are 50 million to 80 million pounds in 1960, more than 120 million pounds in 1963.

Several routes to caprolactam are commercially feasible. Key is the method selected for production of intermediate cyclohexanone oxime. A clue to the routes chosen by major producers is given by the available byproducts: Cyclohexylamine from DuPont's process and ammonium sulfate at National Aniline. For any of the industrially feasible methods, either cyclohexane or phenol may serve as raw material. National Aniline appears to use phenol, while DuPont will start from a cyclohexane base. Technical details will be provided in Part II.

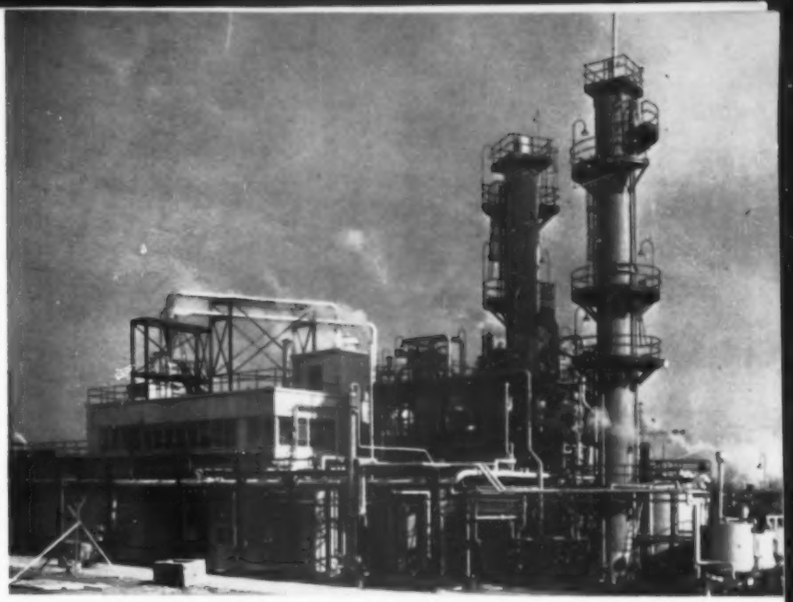
Caprolactam offers a potentially lower-cost raw-materials base than hexamethylenediamine. With new caprolactam facilities going onstream, price of the material is coming down from 57 cents per pound in late 1958 to an expected level below 50 cents per pound. For hexamethylenediamine, which is almost entirely consumed captively, a posted price is not available, but raw-materials cost alone (in the adipic acid-ammonia process) is in the 55 cents to 60 cents per pound range. This raw-materials cost becomes less in a fully integrated operation, depending on the method of internal bookkeeping employed. Overall, however, lower cost of intermediates provides a competitive advantage for nylon-6 over the more firmly established nylon-66.

II. Petrochemical Technology—

A. Adipic Acid: Key intermediate in the production of adipic acid is cyclohexanol. This may be obtained by the hydrogenation of phenol (National Aniline) or by the partial oxidation of cyclohexane (DuPont, Chemstrand). Flow is illustrated in Fig. 1. The hydrogenation of phenol is a fairly routine operation. It is carried out in the vapor phase over supported nickel catalyst which is, in many instances, promoted; e.g., by chromium, manganese, cobalt, or copper. Cyclohexanol obtained in this manner is converted to adipic acid using nitric acid as oxidizing agent. The technique is described below.

Conversion of cyclohexane to adipic acid is effected commercially in two steps: air

Fig. 1. Petrochemical routes to adipic acid.



National Aniline Division's adipic-acid plant at Hopewell, Va.

oxidation to a mixture of cyclohexanol and cyclohexanone, followed by nitric-acid oxidation of these intermediates to adipic acid. The first step in this synthesis is carried out in the liquid phase, i.e., by passing air through cyclohexane. The temperature range is 120 C to 150 C. To maintain the liquid phase, a system pressure between 3.5 and 5 atmospheres is called for. Several catalysts are mentioned in the patent literature; the best results have been reported for the use of cobalt naphthenate.

As is generally the case in autoxidation of hydrocarbons, an incubation period is observed. This may be overcome by the use of an initiator e.g., a peroxide or a ketone. Cyclohexanone itself is an effective initiator, and the problem of reaction delay is thus not serious in a continuous process for the oxidation of cyclohexanone.

Low conversion is taken per pass. As the allowed degree of oxidation is increased, yield drops because of the formation of higher oxidation products. Furthermore, reaction rate drops as the degree of oxidation progresses, and oxygen absorption eventually becomes negligible.

It has been found that presence of moisture, benzene, and sulfur in significant amount depresses both the conversion rate and yield. Steps must, therefore, be taken for removal of these contaminants from both feed stock and recycle cyclohexane. Water of formation is removed continuously from the reaction system.

In the process due to Hamblet and Chance[1] the reaction is carried out in a series of three stirred autoclaves. Each autoclave is equipped with an overhead reflux condenser which is provided with means for water withdrawal. Air enters the bottom of each autoclave. Effluent from the final reaction stage is steam-distilled for the ovehead removal of hydrocarbons. The bottoms is the desired crude oxidation product. The overhead is water-washed and then subjected to azeotropic distillation for overhead removal of benzene and other hydrocarbon contaminants and bottoms recovery of cyclohexane to be recycled to the first oxidizer stage.

Typical operating conditions call for a temperature of 125 C to 165 C, a corresponding system pressure of 50 to 250 psi, a catalyst (cobalt naphthenate) concentration of 0.05% by weight on cyclohexane, and use of an initiator (e.g., a small amount of recycle crude oxidation mixture). Per-pass conversion is 12% to 15% for large-scale operation. This provides a yield of (pure) cyclohexanol and cyclohexanone of 60% to 75%, but the yield of total products convertible to adipic acid is 80% to 85% of theory.

Oxidation of crude cyclohexanol-cyclohexanone mixture to adipic acid is effected by means of nitric acid. Yield and permissible operating temperature range can be increased by use of a variety of catalysts. Particularly favorable performance has been reported by copper-vanadium catalyst (approximately 0.25% Cu and 0.1% V). Such a system permits yields of 90% to 93% at temperatures ranging from 55 C to 85 C and with nitric acid of 50% to 60% strength.

Byproduct formation can be largely suppressed, and adipic acid yield correspondingly increased, by maintaining a low concentration of nitric acid at all times. Oxidizing agent and cyclohexanol are added continuously to a relatively large body of reaction liquor. Product is withdrawn at a rate equal to the volume of incoming streams.

A continuous process with low local concentration of nitric acid is covered by Hamblet and McAlevy.[2,3] This work recognizes the superiority of crude cyclohexane oxidation product over refined cyclohexanol and cyclohexanone when used as feed to adipic-acid synthesis. The crude air-oxidation product is freed of unconverted hydrocarbon prior to HNO_3 oxidation.

In Hamblet's process, cycloalkane-free product of the preliminary air oxidation and a nitric-acid solution of 50% to 60% strength, containing copper-vanadium catalyst, are separately and continuously introduced into a reaction tube through which the reaction mixture is rapidly circulated. The system pressure is 2 to 10 atmospheres. Temperature is held at 60 C to 80 C. By jacketing the reaction tube, heat removal from the circulating reaction mixture to external coolant may be readily effected.

The preferred weight ratio of nitric-acid stream to organic feed is between 15 and 25. Weight ratio of 100% nitric acid in the feed to organic feed is between 2.5 and 6.0. The rate of admittance of organic feed to the recirculation system should be such that the average contact time is of the order of five minutes. Since gaseous nitrogen oxides are evolved in the course of reaction, provision must be made for their removal from the system, their recovery, and their eventual reoxidation to nitric acid.

Hamblet reports that substantial improvement in yield can be achieved by following the relatively mild primary nitric-acid oxidation step described in the preceding paragraphs—with a second, more drastic, oxidation stage. For this purpose, a stream of primary oxidation mixture is continuously withdrawn from the circulating system. The effluent is heated to 95 C to 100 C and held at this temperature for about seven minutes. The continuing exothermic reaction must be controlled by external cooling.

Crystallization of adipic acid from the reaction mixture is effected by cooling, and the product is recovered by centrifuging. Mother liquor is vacuum flash-distilled for overhead recovery of nitric acid.

With tubular reactors, the hazard of local overconcentration is minimized by using efficient injection systems and turbulent flow of the circulating liquid. Where autoclaves are used, the feeds may also be injected into the liquor circulating through the external heat exchanger. However, Lindsay reports good performance also when the organic feed is introduced into the first autoclave below the liquid surface and close to an efficient agitator.

As typical operating data, in continuous reactors with external recirculation, Lindsay[4] cites a ratio of nitric acid (calculated as 100% HNO_3) to organics of 4.5:1. Feed acid strength is about 53%. The recycle contains about 33% HNO_3, and the concentration just downstream of the HNO_3 feed point is approximately 45%.

Ratio of recirculating liquor to organic feed may be as high as 50:1. Overall hold-up in the first reactor is 5 min to 10 min, and a like period is provided in the second conversion stage. Copper-vanadium catalyst is used.

At such operating conditions, yield in the primary reactor is better than 90%. An additional 3% yield can be attained in the second converter.

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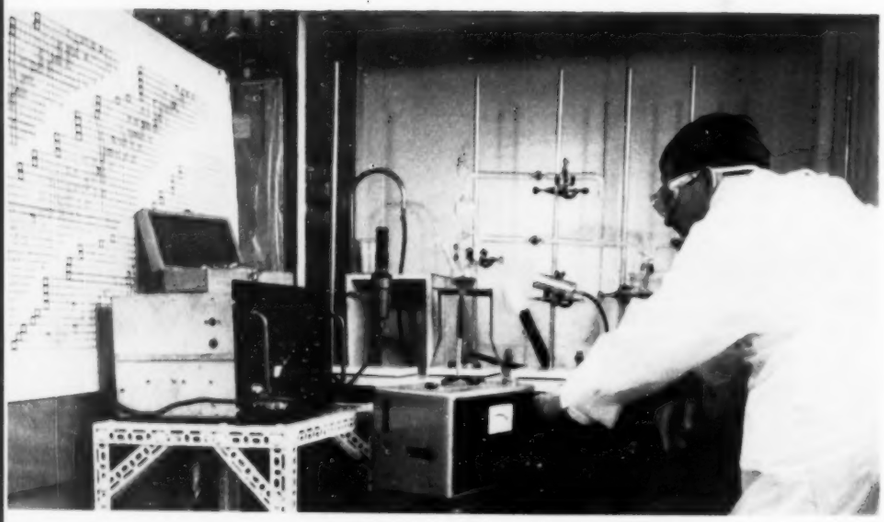
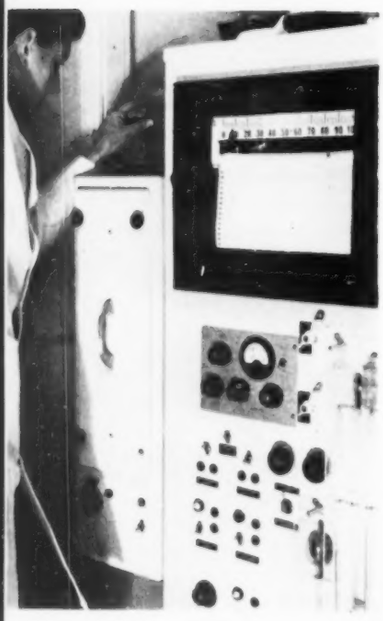
Expansion at Wakefield's research laboratories and additives plant

by G. H. Thornley, M.Sc.*



Above: Gas chromatography apparatus for quantitative analysis of mixtures of liquids and gases.



Left: Direct reading emission spectrograph which automatically determines proportions of a pre-determined number of elements in a material.

Below: Development of radiation resistant lubricants for use in Britain's nuclear power station.

It is just 60 years since the foundation in Britain of C. C. Wakefield & Co. The headquarters of the Wakefield research department is at Hayes in Middlesex, and it is here that a new laboratory block, with many interesting features, has recently been opened. The building houses a new organic chemistry laboratory, a physical-chemistry laboratory, a library and conference room, laboratory workshops, stores, and a production control laboratory. The older laboratories have been converted into expanded development, sales service, routine and analytical laboratories, all with improved instrumentation.

The plans for the new building were aimed especially at dealing with space limitations at the site. Thus ceiling heating has been used throughout in order to save the wall space normally taken up by radiators; and a special ventilation system has been used in the organic laboratory. Here a system of bays has been used, separated from one another by glass partitions but open to the laboratory at one end. Each bay is completely furnished with fume cupboard, desk, and all services to house a small team. This design is calculated to develop a sense of individual responsibility in dealing with projects. The benches in the organic laboratory have been built with an air trunking just above the working level at the back of the bench, in order to draw fumes away from the workers. Filtered fresh air, warmed if necessary, replaces that drawn out by the fume hoods and the bench exhaust louvres.

Modern instrumentation throughout the laboratories is demonstrated by the following: An 11-channel Hilger medium quartz direct reading spectrograph determines the proportions of up to 10 elements in two minutes, working directly with oil samples without ashing. This instrument is proving invaluable for examining the additive content of lubricants for control or research purposes, and for wear studies in conjunction with the engine test laboratory.

The long-term storage stability of additives in oil is studied by the use of a refrigerated centrifuge. This instrument is capable of giving 26,000 g, and can be maintained at − 20 C. Samples of one-pint size can be tested at 1,160 g.

Flame photometry is used for determina-

*Group Technical Manager, Wakefield (Castrol) Group.

tion of alkali metals, especially in greases for which a direct method eliminating ashing is under development.

Infrared spectrophotometry is finding increasing application, not only in connection with the chemical structure of unknown substances, but in the development of methods of preparation of new organic materials. Similarly, gas-liquid partition chromotography has been given much attention for several years. The apparatus for these techniques has now been re-assembled in the physical-chemistry laboratory, and the present version of the GLPC unit can be operated at temperatures up to 250 C, making it especially useful for work on synthetic lubricants.

Because of the trend to higher test temperatures, the oxidation laboratory has been given special ventilation arrangements. Oil-heating baths are being largely replaced by aluminum block heaters.

A separate laboratory is provided for work with radioactive materials, with the appropriate instrumentation. All is constructed with a view to ease of cleaning, or decontamination, should this ever prove necessary. The research program involves both the use of radioactive tracer elements and the experimental irradiation of lubricants and related products. The development laboratory is equipped with rig tests for the study of radiation-resistant lubricants under conditions simulating those occurring, or liable to occur, in nuclear reactors of power plants.

In the production control laboratory, the samples from the works are received by a vacuum-tube conveyor system. Speed in the work of this section is essential, and an improved type kinematic viscometer has been developed. This is based on a design which was found useful in the company's French laboratories. Using only 0.5 ml of oil, a viscosity determination requires only five minutes as compared with the 30 minutes needed by the conventional capillary viscometer. The tubes are mounted permanently on the heating baths and are cleaned *in situ*.

The technique for Karl Fischer water determination has been greatly improved. Determinations on oil samples down to a few parts per million of water can be made with a precision of one part per million, and successive determinations can be made in approximately 10 minutes per sample.

Engine Test Facilities: The engine test laboratory has been considerably extended since it was built in 1948. Originally designed for 12 engines, it now houses 24, comprising no less than 13 different types. This expansion has been made possible by the acquisition of additional space for dismantling, cleaning, and re-assembling, with some additional office facilities.

In addition to the usual standard Caterpillar and Chevrolet engines, there is a wide range of automotive and industrial types, both petrol and diesel, two-stroke and four-stroke. Considerable use is made of Petter AVI and WI engines for research purposes; test procedures using both these units are in process of standardization by the Institute of Petroleum.

The new CLR engine, which is replacing the Chevrolet in the United States, is installed; and Lister and Ruston diesel engines, modified for research purposes, are used for the investigation of cylinder lubrication problems with boiler fuel. Other engines are used for the study of cold sludge problems and cam and tappet wear.

The installation includes a variety of dynamometers, including electric motoring and absorbing units with special control gear, in addition to dynamatic and hydraulic types, and air brakes for the smaller engines.

Work on wear problems is aided by air gauging methods for cylinder bore measurements, and use is also made of spectrographic analysis of crankcase oil, which is in some respects more informative than radioactive methods.

A mechanical tests room is equipped for work with the SAE, Four-Ball, Almen, and Timken wear test machines. The results of work in this field, correlating with hypoid axle tests, have recently been published elsewhere.

Pilot Plant: A large pilot-plant section for additive manufacture has been developed over the past few years. This has been designed with a special view to its versatility. The main area includes three stainless-steel agitated reactors, two of 40-gal capacity and one of 120-gal capacity. These are equipped for heating and cooling, and are fitted with automatic control. One of the smaller vessels is especially adapted for carrying out heterogeneous gas-liquid, or liquid-solid reactions.

Available for work with these vessels are filter presses, vacuum pumps, and similar subsidiary equipment. Certain materials required in very pure form are unsuitable for filtration by presses, and these are handled by heat-resisting ceramic vacuum filters. Separations not readily performed by filtration are effected with centrifuges operating on a continuous basis at up to 13,000 g.

Also in commission is a glass-lined steel vacuum distillation unit, and two 1,500-gal heated blending pans with variable-speed agitators mounted on staging over the filter presses. A flameproof area contains a further glass-lined steel reactor with all-glass fractionating column and ancillaries. The flameproof area is fitted with an automatic CO_2 fire-fighting system. A wide range of heat exchangers, columns, reflux dividers, etc., is held in stock to facilitate rapid changes in layout to suit new problems. With this in mind, the whole arrangement has been designed for maximum flexibility, and a wide range of temperatures and pressures can be employed.

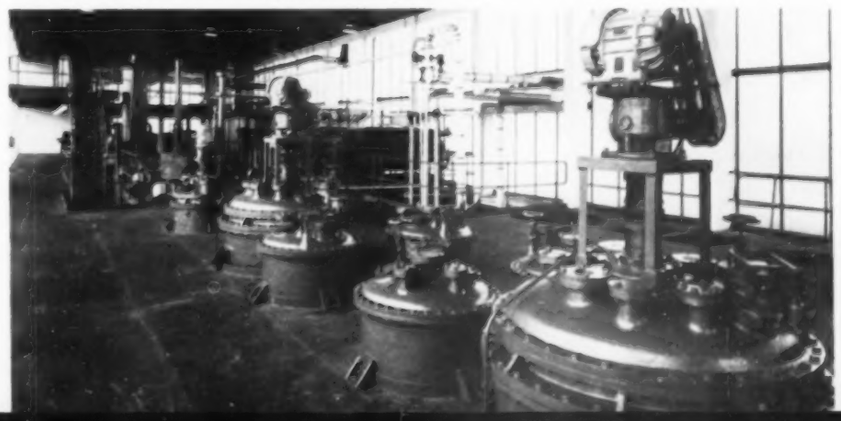
Other facilities available include drying ovens and a variety of mixing and milling equipment. Special provision is made for the destruction or absorption of effluents in order to minimize atmospheric pollution.

New Chemical Plant: The main production plant of the Wakefield group is at Stanlow in Cheshire. Here, in addition to the manufacture of a large range of lubricants, additives, and other chemical products are also produced. Wakefield was the first company in Great Britain to use additives in its branded motor lubricants, having first sold this type in 1935. At the same time it embarked upon a policy of manufacturing additives for its own use, and this policy has been pursued throughout the years.

The first equipment, initially for the manufacture of tin and chromium compounds for use as antioxidants and detergents in motor oils, was erected at Hayes, together with the first plant to produce thioethers as load-carrying additives for gear oils. These additives were developed through the years, and in 1950 more up-to-date units were designed and erected at the new Stanlow works. In addition to the developed tin and chromium additives, facilities were provided for the manufacture, in large amounts, of antioxidant additives of the dithiophosphate type, together with detergents of the basic barium and basic calcium petroleum sulfonate type. These plants have been improved and increased in capacity during the years.

This year a new building with several new units is being brought into use at Stanlow. The dithiophosphate unit will increase the capacity at Stanlow of this type of additive by 300%, while the capacity for detergent additives has been increased by approximately 400%. In general, the same type of process, with many refinements, is being used for the manufacture of these additives as was used in the past, but in the case of the extreme-pressure additives, a plant of completely new design has been erected and is now in use. The general-purpose additive plant enables other additives, for various purposes, to be made at least in comparatively small quantities. These additives cover compounds for use in synthetic lubricants for gas turbines, load-carrying steam-turbine oils, corrosion inhibitors, and special detergents for marine diesel engines. In addition, this general-purpose additive plant is capable of being adapted at short notice to manufacture other additives at least on a pilot-plant scale. END

General view of upper floor at Wakefield's Stanlow chemical plant.



General view of Esso petrochemicals plant at Fawley. Photo by Elwood M. Payne for Foster Wheeler, Ltd.

Esso's new UK petrochemical plant

At the Esso refinery, Fawley, on December 5, 1958, Lord Mills, Minister of Power, inaugurated a new £10 million plant for the production of petroleum chemicals. The new plant is designed to produce as its main products 40,000 tons per annum of ethylene and 42,000 tons per annum of butadiene. The units were designed and built by Foster Wheeler Ltd., who were the main contractors.

This article, which reviews certain features of plant design and operation, is divided into two sections dealing with the production of (1) ethylene, (2) butadiene.

ETHYLENE PRODUCTION—Methods of Manufacture: There are four principal methods available for the production of ethylene. The choice of a given method depends primarily on economic factors:

1. *Recovery from catalytic cracker gases:* Ethylene occurs in the gaseous fraction which results from catalytic cracking, but the quantities available are seldom sufficient to justify recovery. Reliance on this source has the further disadvantages that it is tied closely to gasoline production, and that it provides no byproducts.

2. *Regenerative refractory cracking:* In this system, a refractory previously heated by flue gases supplies the heat of cracking in a cyclic operation. Fuel is first burned to heat the refractory to a high temperature, following which the fuel is turned off and the furnace is purged with steam or inert gas. The feed stock is then passed through the furnace, and cracking takes place until further heating is required. The process permits the use of higher temperatures than are attainable in other cracking operations.

3. *Steam-heat carrier cracking:* The heat of cracking may be provided by a heat carrier, such as steam superheated to 1,700 F in a special furnace. The feed stock is vaporized separately and heated to 1,000 F. The steam and the feed stock are mixed in a transfer line where the actual cracking takes place, and the cracked products are quenched on leaving it. The main disadvantage of this method is that very expensive alloys are needed in the steam superheater.

4. *Coil cracking:* In coil cracking, the feed stock is passed through a tubular coil in a special furnace which has a radiant and a convection section and is so designed that the feed stock leaves the convection section at about 1,000 F. The cracking takes place in the radiant section where the temperature is quickly raised to between 1,400 F and 1,500 F.

The feed stock can be any stream ranging from ethane to gas oil. The method produces a variety of byproducts which can be utilized within the refinery, or as chemical raw materials.

The process in use at Fawley is a type of coil cracking known as steam cracking. The feedstock is diluted with steam before entering the furnace, in order to insure a low hydrocarbon partial pressure at the outlet. This reduces the tendency towards recombination of the cracked product

The furnace is characterized by a radiant section with a high heat density, in which the feed residence time is less than one second. The furnace walls and tube hangers reach temperatures of 2,000 F. Immediately after leaving the furnace, the cracked products are quenched either with water or oil to prevent the formation of polymers.

Ethylene purifications: The ethylene recovery unit is designed to produce ethylene of extremely high purity to meet customers' specifications. The feed to the unit is a C_2 and lighter stream from the absorber deethanizer and sponge absorber towers, containing between 0.1% and 1.0% acetylene. This requires to be reduced to less than 50 ppm in the product ethylene.

The reduction is achieved by selective hydrogenation of acetylene in the presence of steam over a catalyst. With careful operation, it is possible to keep the hydrogenation of ethylene at a low level.

The separation of the ethylene from the other principal components—hydrogen, methane and ethane—is achieved by low-temperature fractionation in a demethanizer tower followed by an ethylene-ethane splitter tower. Since this occurs at sub-zero temperatures, the gases require to be carefully dried. Two driers are used in series, while a third is being regenerated. The driers are changed every 24 hours.

Refrigeration: In order to reach the low temperatures required for the separation of methane and hydrogen from ethylene and ethane, a refrigeration system is necessary. Because of its availability, ethylene is used for the lower temperatures. Its critical temperature is +50 F, and an additional refrigeration circuit has, therefore, to be employed to cool and liquefy the compressed ethylene gas as well as for other refrigeration purposes. Propylene is available as a highly pure stream from the light-ends

fractionating equipment, and for this reason is used as the second refrigerant. There are three levels of propylene refrigeration and two of ethylene refrigeration, obtained by returning vaporized refrigerant for recompression at intermediate stages in the compressors.

The use of low temperatures has meant that particular attention has had to be paid to the metals used for construction. Carbon steel is safe down to temperatures of −20 F, and killed carbon steel to −50 F. For lower temperatures, down to −150 F, 3½% nickel steel may be used. It is difficult to weld, but is otherwise suitable. Below −150 F, stainless steel has to be used. Aluminum is safe for low-temperature services, but will melt in the event of a fire and is, therefore, not used.

Light-ends separation: The fact that steam cracking produces valuable byproducts in addition to ethylene has already been mentioned. These products are separated as a C_3 stream which is almost pure propylene, a C_4 stream containing butadiene, and a C_5+ stream which is used as a gasoline-blending component after treatment.

The propylene stream is at present routed to the polymerization plant—where, together with other streams, it is converted to gasoline. Butadiene is extracted from the C_4 stream.

Octane improvement: The C_5 stream from the light-ends separation plant passes to a clay-treating unit, where it is treated to polymerize reactive components, and is then rerun. The overhead product is steam-cracked naphtha with an octane number of about 80, compared with 55 for the feed to the cracking furnaces. The tower bottoms is a polymer which is suitable for blending with fuel oil; it may also be a source of valuble chemical raw materials.

Methods of dispatch: Ethylene is sent as a gas by pipeline to two customers who have factories located near the refinery. It is also sent as liquid in insulated road cars to three other customers at distances up to 250 miles away. The liquid is held at a temperature of approximately −140 F and a pressure of about 15 psig. The road cars hold between 7 and 9 tons each, and the processes of loading and transportation proceed as smoothly as for any other bulk liquid dispatch.

Uses: Ethylene is one of the most versatile of the olefins. Fig. 1 shows some of its more important uses.

The most important single use of ethylene is in the manufacture of polyethylene. At least three different processes are in commercial use. Of these, the original ICI process involves the use of pressures exceeding 20,000 psi, at a temperature of 375 F, with a small trace of oxygen as the catalyst. The Phillips Petroleum Co. process dissolves ethylene in xylene and adds a catalyst such as molydenum oxide. The polyethylene is formed at about 500 psi and at temperatures of 350 to 500 F, and is then separated from the solvent by filtration. In the Ziegler process, the polyethylene is formed at less than 100 psi, at temperatures of 140 F to 170 F. A combination of aluminum triethyl and a compound such as titanium tetrachloride is used as a catalyst.

BUTADIENE PRODUCTION: Butadiene is produced for use by the International Synthetic Rubber Co., Ltd., in the manufacture of styrene-butadiene copolymer rubber (SBR). Several processes are available for the production of butadiene; these include:

1. Pyrolysis of hydrocarbons as, for example, in the steam-cracking process described earlier.

2. Dehydrogenation of butane using the Houdry one-step vacuum process.

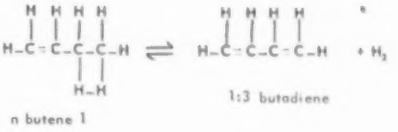
3. Dehydrogenation of butane using the Phillips two-stage process.

4. Dehydrogenation of butenes by the Esso process with either Shell 205 or Dow Type B catalyst.

5. Alcohol dehydration using ethanol as feed stock.

At Fawley, some butadiene is recovered from the steam cracker C_4 stream, but the quantity is insufficient to meet the customer's requirements. A separate unit for the production of butadiene had, therefore, to be installed. At the time of the economic study to choose the most suitable butadiene production process, the availability of butenes from the refinery cat-cracker outweighed the supply of butane. The most suitable process was, therefore, dehydrogenation of butenes using the Esso steam-dilution process. (Following the recent installation of a non-selective polymerization plant and a heptenes plant, however, the butane-butene balance on the refinery has now changed, butane being more plentiful.)

In the Esso process, butene feed is preheated to 1,000 F, mixed with excess steam, and the mixture passed through a fixed-bed catalyst wherein the following reaction takes place:



The use of a large excess of diluent steam, 14-18 mols steam per mol butene, lowers the hydrocarbon partial pressure and favors the formation of butadiene.

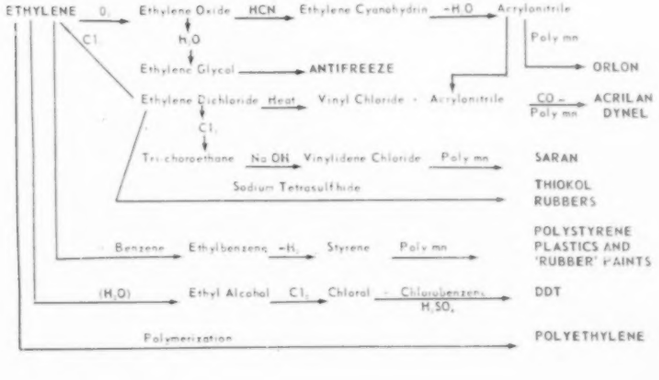
The choice of catalyst for the process lay between Shell 205 ferric-oxide catalyst and the Dow Type B calcium-nickel phosphate promoted with chromic oxide. Economically, the Dow catalyst is the more favorable as it can give a 90% selectivity at conversion levels of 35-40%, whereas the Shell catalyst gives only 70% selectivity at 25% conversion.

Process considerations, however, favor the Shell type. It is a rugged catalyst with a life of about 15 months, which requires no cyclic regeneration but only bi-weekly steaming to maintain catalyst activity. The Dow catalyst is very sensitive to poor distribution of reaction and regenerative gases, has a life of 6-9 months and requires more diluent steam in the reaction gases than does the Shell catalyst. It also requires cyclic regeneration with air and steam, necessitating the installation of a cycle timer and motor-operated valves. In addition, the Dow catalyst gives rise to more acetylene and carbonyl type compounds, and facilities must be installed to remove these substances which would otherwise decrease the solvent-extraction efficiency on the butadiene extraction unit.

An economic study revealed that the higher selectivity and conversion obtainable with Dow catalyst would permit capital savings on the new dehydrogenation unit which would outweigh the higher operating costs. Dow Type B catalyst was, therefore, adopted.

Consideration of the entire butadiene pro-

Fig. 1.



Ethylene purification plant at Fawley. Acetylene conversion unit is in the center foreground. In this unit acetylene impurities in the stream are catalytically converted to ethylene. An Esso photo.

duction process may be divided logically into feed preparation, butene dehydrogenation, and butadiene extraction.

Feed Preparation Unit: Feed for the unit is a C_3-C_4 stream from the refinery catalytic cracker. As n-butylene is the only component which gives rise to butadiene, feed preparation is necessary to reduce diluents to a minimum.

The cat-cracker stream passes first through a depropanizer tower and a deisobutanizer tower where it is reduced to a mixture of n-butane and *n* and iso-butylene.

The isobutylene is then removed by acid extraction in the dimer unit. This unit consists of a two-stage reactor-settler in which the hydrocarbon flows countercurrent to 65% sulfuric acid. Isobutylene is selectively extracted by the acid. The acid extract is separated from the raffinate hydrocarbons and passes to a heater where the isobutylene dimerizes to di-isobutylene and the sulfuric acid is regenerated. The dimer is separated from the acid, recombined with the raffinate butylenes, caustic-washed, and fractionated in the dimer-plant debutanizer. The overhead product from the tower is the concentrated n-butylene feed to the dehydrogenation unit, while the bottom stream from the tower, essentially dimer, is used in motor gasoline blending.

The corrosive nature of the extraction process has necessitated the use of Karbate, lead lining, and special alloys in the construction of the dimer unit. Karbate, a resin-bonded graphite, is used for the dimer heater and cooler; it has good anti-corrosion properties but is a fragile material, and components made from it require care in assembly.

Butene Dehydrogenation Unit: The concentrated n-butene stream from the dimer plant debutanizer is preheated in a cabin furnace and then diluted with a large excess of steam which has been superheated to 1,400 F in a large vertical cylindrical furnace. This furnace is believed to be the largest of its type in Europe.

The steam-butene mixture passes, at approximately atmospheric pressure, to one of two dehydrogenation reactors containing beds of Dow Type B catalyst. The reactors work alternately on a 30-minute cycle of reaction and regeneration. Cycles are governed by 12 air-motor-operated valves opening and closing on air signals from a sequential timer-controller in the unit control room. Temperatures at various points in the catalyst beds are measured by numerous thermocouples arranged in three levels. The results are recorded continuously, the temperature-time pattern being indicative of the state of the beds. Regeneration of the catalyst is carried out by a mixture of air and steam, the completeness of the regeneration being judged by the CO_2 content of the effluent gases as recorded by an infrared analyzer.

The product from the reactors is a dilute butadiene stream which is cooled by waste-heat boilers, oil quenching, water quenching and, finally, by passage through a bank of air fin coolers containing 24 fans. This is the first large-scale installation of air fin coolers at Fawley.

The cooled hydrocarbon vapors are next compressed in a 2-stage centrifugal compressor and then fractionated: first to remove propane and lighter hydrocarbons, then to remove traces of absorber lean oil. Finally, the stream is water-washed in a tower to remove acetone and other carbonyl compounds formed in the dehydrogenation process.

The unit has a large condensate recovery system which includes de-oiling facilities and a water-stripper tower. Condensate recovery is important due to the high steam consumption of the process.

Butadiene Extraction Unit: Feed to this unit comes from the butene dehydrogenation unit and the steam cracker. Butadiene is recovered from both streams by the Esso process which employs cuprous ammonium-acetate solution (CAA) as the extracting solvent.

Each stream is first subjected to a pretreat with CAA for the removal of acetylenes, since the presence of these compounds in butadiene is deleterious to the manufacture of SBR rubber. The acetylene removal section employs an orifice mixer and settler for each feed stream together with a butadiene flash drum, an acetylene stripper, and drums containing activated charcoal for the treatment of the CAA.

Extraction of butadiene is carried out by countercurrent flow of hydrocarbon and refrigerated CAA through a series of turbo mixers and settlers. Steam-cracked and dehydrogenation feeds are handled in separate extraction trains. The extracts from the two trains are then combined and passed through stripping stages against a hydrocarbon reflux, produced by warming the extract to the final settler.

Butadiene is stripped from the rich CAA solution in a desorber tower, after which the lean CAA is cooled and treated with activated charcoal to remove polymers before being returned to the system. After water washing to remove traces of ammonia, the butadiene is rerun in a single fractionating tower, being condensed overhead using propylene refrigeration. The product is then inhibited against polymerization and sent to storage in spheres, whence it is delivered to the customers by pipeline at 98.5% purity.

Most of the spent butenes from the extraction trains are returned to the refinery for polymerization to motor gasoline, but a small stream is recycled to the dehydrogenation unit.

Ammonia is removed from the various hydrocarbon streams by scrubbing with water; it is then recovered in an ammonia fractionator.

Refrigeration for the unit is provided by a compressor furnishing liquid propylene at two temperature levels. The compressor is driven by an English Electric gas turbine of 2,650 hp running on refinery fuel gas, the first machine on a process unit in the UK to run continuously on a gaseous fuel.

A CAA make-up section contains facilities for the batch handling of the solution's constituents.

Facilities are also provided for the treatment of water contaminated with CAA solution. These include a sewer system, collecting basin, blue pond, and a cooker-settler. Because of the extremely poisonous effect of copper salts on marine life, stringent precautions have to be taken to prevent contaminated water from being discharged to Southampton Water. The above facilities enable the copper content of the water to be reduced below 10 ppm before discharge from the cooker-settler, while the copper concentration in the total effluent from the unit is less than 1 ppm. END

Butadiene plant showing extraction unit in foreground. Tall tower in the center is part of the dimerization unit in the background. The tower is part of the butene dehydrogenation plant. An Esso pl...

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General view of Greek government refinery.

Greek government refinery in full operation

by J. E. Bogk[1] and Dr. Morgan C. Sze[2]

PLACED on stream last November the Greek Government refinery at Aspropyrgos near Athens now is meeting the basic oil requirements of the nation. Estimated total oil consumption in Greece during 1959 is about 37,000 b/d and the new refinery is running at the rate of about 35,000 b/sd. Design capacity of the plant is 30,000 b/cd. Before the plant was commissioned Greece was importing over $50 millions of petroleum products per year so that the refinery now is contributing substantially to the saving of foreign exchange.

Like many of the most recently built plants in Europe HRI designed the Greek refinery for minimum gasoline production and a maximum yield of middle distillates. Principal processing units include the crude still, vacuum unit, catalytic reformer and asphalt blowing unit together with the usual gasoline stabilizing and treating facilities.

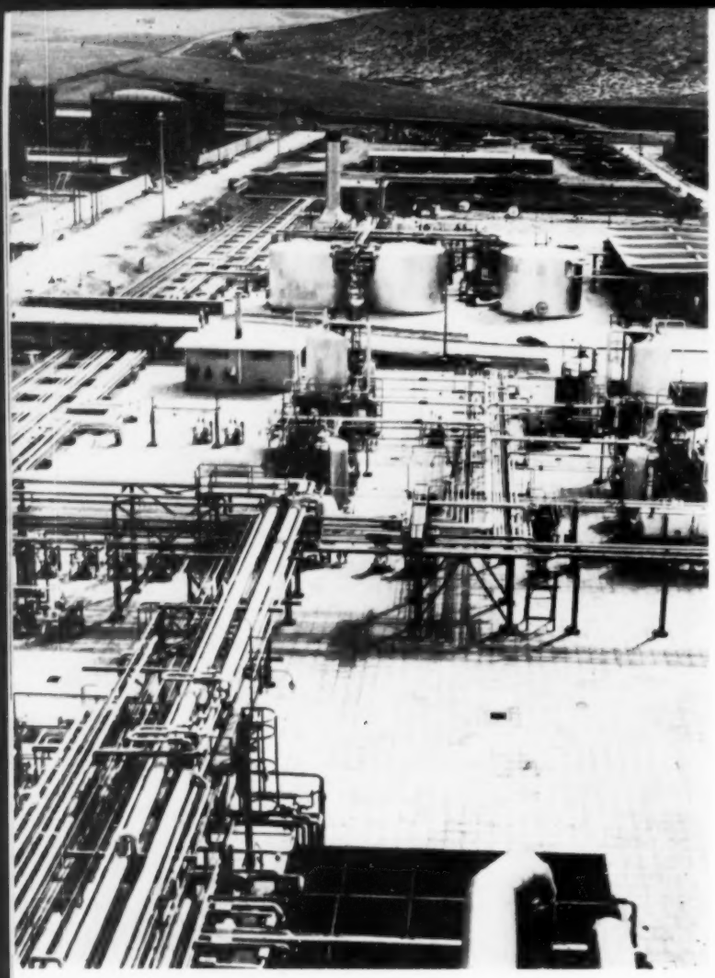
Product emphasis is on maximum yield of high quality diesel fuels with other products being motor gasoline, jet fuel (JP4), kerosine, residual fuels and asphalt as required to satisfy the Greek market. Asphalt output is enough to pave 400 km of new roads per year. Lubricants still must be imported to satisfy the local markets.

The refinery is tied into a distributing system designed to reach all parts of the nation at minimum cost. About 20% of the finished products are pumped through dual pipelines to the Athens market. Another 15% is dispatched by tank truck from refinery landing facilities to Athens and to inland markets. The remainder moved by tankship from the refinery landing pier to various ports, of which Greece has a great number. Asphalt is being moved in local made drums.

Construction of the refinery was begun in early 1956. Hydrocarbon Research Inc. was the general contractor. Affiliates in the project included Hydrocarbon Mineraloel, Friedrich Krupp and Stahlunion Export of Germany. The plant was completed in 22 months but operation was delayed while consideration was given by the Government to the plan which was to be followed—leasing to oil companies or operation as a Government project.

The refinery has been leased for ten years to Hellenic Petroleum Refineries, a Greek corporation, and Hydrocarbon Research was selected to supply technical and operating management for the refinery during the term of the lease. Hydrocarbon's management team arrived at the refinery in June 1958

[1]Manager of Operations. [2]Director, Process Engineering, Hydrocarbon Research, Inc.



Piping runs from distillation plant to treating area. Asphalt preparation unit is in background.

and actual schooling and training of Greek nationals started shortly thereafter.

Initially a foreign staff of 80 (including vendors' representatives) was sent to the refinery for training the Greek personnel and for start-up operations. The foreign staff has been reduced gradually to a present level of about 45-50 of HRI personnel and this number will be further decreased in September.

Staff training was accomplished through classroom work and on-the-job experience. Job responsibility is being transferred to Greek nationals as rapidly as individual progress permits. The HRI staff is gradually assuming the role of advisors and consultants.

Greek personnel totals about 500 of which 370 are in operation and the balance are in administration.

Middle East crude is being supplied at present by Socony Mobil. Three 35,000-ton tankers are in service between the refinery and the Persian Gulf. Round trip time for the 18-knot tankers is 28 days.

Crude is discharged at a pier at Megara some 22 kilometers from the refinery proper. At the pier head water depth is 13 meters allowing the discharge of cargo by supertankers. Crude is pumped through an 18" line to an adjacent tank farm from which it is transferred on a continuous basis through a 12" line to the refinery itself as required.

Coastal tankers serving various Greek ports do not require deep water berths so a pier has been built at Eleusis Bay, adjacent to the refinery, for offloading of finished products. Asphalt drums as well as bulk liquid products are handled from this dock.

There are 50 crude, intermediate and finished products tanks at Megara and at the refinery with a total capacity of 1,600,000 barrels. Of these tanks 20 are equipped with floating roofs. The finished products storage capacity is approximately equal to 20 days production at current operating levels.

The crude still is equipped with a heater rated at 102 million Btu/hr. heat duty. The main tower is about 14 feet in diameter and is equipped with Uniflux trays except the vacuum tower which employs conventional bubble caps. All refinery equipment was fabricated in Europe.

When charged with 34.2 gravity Iranian crude at the rate of 36,000 b sd the tower operates at 1.18 kg cm^2 gauge top pressure to produce the following cuts:

	Gasoline	*Naphtha*	*Kerosine*	*Diesel*
Sp. Gr.	0.6904	0.7593	0.7825	0.8378
IBP	30°C	102°C	153°C	188°C
5%	40	122	160	224
10%	49	126	162	232
30%	67	131	167	252
50%	82	135	171	271
70%	95	139	177	296
90%	118°	147	189	330
95%	—	153	197	343
Recovery-%	94	98.5	98.5	98.5
RVP-psi	12	—	—	—
Pour	—	—	—	-9.4°C
Flash	—	—	42°C	83°C

Light gasoline is charged to the Catformer built under Atlantic Refining Co. license. When operating on Arabian crude the charge has about the following characteristics:

Charge: Light Arabian gasoline

Sp. gr.	.7012
°API	70.3
ASTM—°C	
IBP	34°C
10%	57
30%	80
50%	104
70%	125
90%	154
EP	182
PONA Analysis:	
Propane	0.6%
iC4	0.6 "
uC4	6.3 "
iC5	5.5 "
nC5	9.4 "
C_6+ Paraffins	56.9 "
C_6+ Naphthenes	13.9 "
C_6+ Aromatics	6.8 "

Yield of 10 lb. RVP reformate from the Catformer averages about 86.2 volume percent the basis at which the unit is operated at present. The reformate inspection follows:

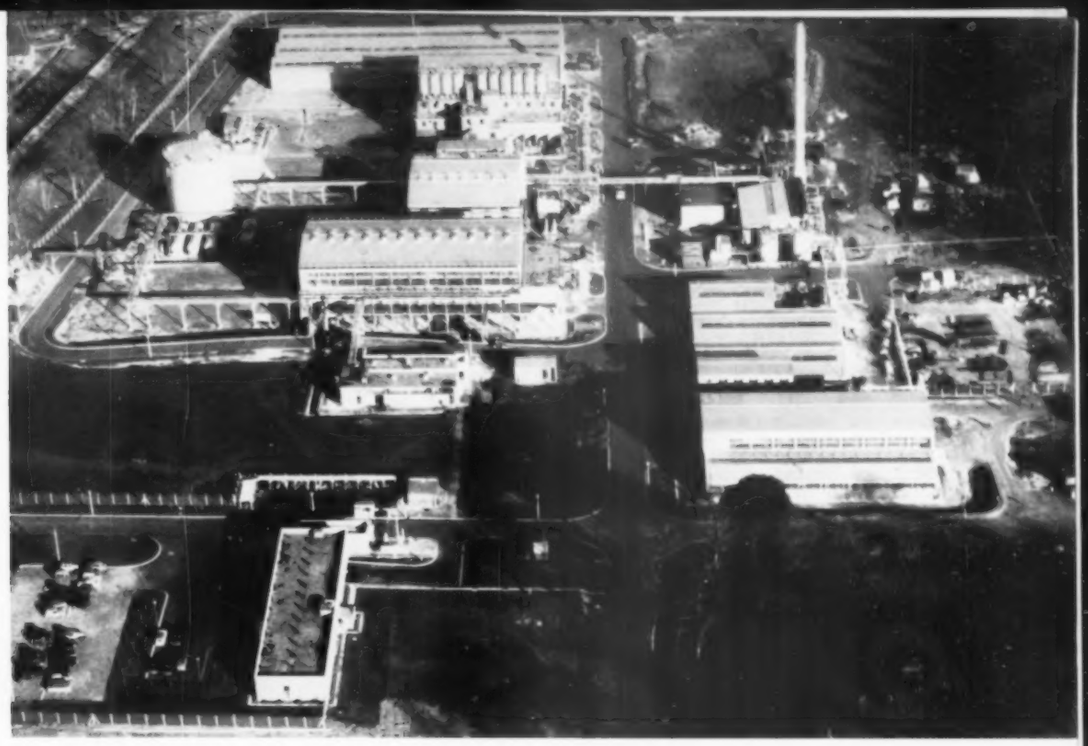
Sp. gr.	.7070
°API	68.6
RVP	8.8
F-1 +1.9cc	84.5
F-1 + 3cc	88.3
ASTM°C	
IBP	43°C
10%	58
30%	72
50%	90
70%	112
90%	148
EP	176
Recov.	96.5

Residuum from the crude tower is charged to the vacuum unit from which a residue is produced with 180-220 penetration at 25°C and a softening point at 37°C. After blowing the asphalt penetration is 85 and softening is at 46°C.

Kerosine and jet fuels are treated before shipment.

The refinery is self-sufficient in most respects. The power plant has a generating capacity of 5,000 Kw and 80 t hr of process steam. Sea water is used for cooling the system having a circulating capacity of 550,000 b d. Fresh water for boilers is purchased. The plant operates its own shops for repair and maintenance.

To meet the future market growth in Greece, expansion plans are underdeveloped. At the moment consideration is being given to the installation of equipment for the recovery of LPGas. Additional Greek industries are also being organized to utilize the by-products of this important addition to the Greek economy.



Monsanto Chemicals' new polyethylene plastic plant at Fawley.

UK petrochemical output rises 165% in five years

"REMARKABLE progress" in production and "still spectacular" capital investment are terms used in regard to petrochemical developments in western Europe as a whole in the recent OEEC report "The Chemical Industry in Europe," a study prepared by its chemical products committee in 1958 and the fifth in the series on this subject.

The same terms may be used with equal truth of the UK. In recent years petrochemicals have represented one of the most rapidly expanding sectors of British industry, probably demanding the highest capital investment per worker of any industry. It is estimated by OEEC, based on unofficial sources, that petrochemicals, which accounted for about 20% of the entire UK output of organic chemicals in 1953, and 35% in 1955, will account for approximately 50% in 1959 and perhaps about 65% and 75% by the middle '60's.

The chemical products committee admits that the very complex nature of the basic organic chemical industry and the large number of products manufactured have so far ruled out any quantitative study of production in this sector. It may be commented that this feature no doubt accounts for the widely varying figures relating to petrochemicals published from time to time. It is thus welcome news that the committee is studying a method for collecting statistics to see if it is possible to analyze the situation more satisfactorily.

It is not easy to define the term "petrochemical," or to decide whether a particular compound is one or not. To the first, the OEEC answer is: "A petroleum chemical is defined as an organic substance the main materials of which have come from oil or refinery gas or natural gas." On the second point, the 1958 report gives—for the first time, it is believed—a full list of the materials which are said to comprise the petrochemicals covered in the report. These are classified as to C_1, C_2, C_3, C_4, C_5 and higher aliphatics, and general. Carbon black and sulfur from petroleum are often considered as petrochemicals, but it should be noted that these are not included in OEEC's "general" class.

Notwithstanding the difficulties of assessment, OEEC puts production of organic petrochemicals (expressed in tonnage of the carbon content) in 1957 as 271,000 tons, an increase of 26% over 1956, and estimates the 1958 total as around 323,000 tons. Many might have expected the last figure to have shown a higher rise over 1957, but the answer probably lies in the fact that several major new plants were only working into normal production in the second half of 1958. The rise in output since 1953, as recorded by the OEEC figures based on a census contributed by manufacturers, is shown in Table I.

The relatively short life of this industry is shown by the fact that 1945 output, is generally regarded as around only 10,000 tons. The 1957 increase was larger than forecast in the preceding OEEC report because of the increase in olefin production capacity. In fact, another source estimates end-1958 total UK capacity for organic petrochemical production as high as 641,500 tons, divided approximately as follows: ethyl alcohol, 115,000 tons; isopropyl alcohol, including quantities converted to acetone and other derivative solvents and intermediates, 113,000 tons; polyethylene, 80,000 tons; styrene-butadiene, 55,000 tons; detergent alkylates, 50,000 tons; ethylene oxide, 45,000 tons; butyl alcohols, including quan-

TABLE I
UK OUTPUT OF ORGANIC PETROCHEMICALS

Year	Long Tons of Contained Carbon	Index 1953-100	Increase Over Preceding Year
1953	122,000	100	—
1954	162,000	133	32
1955	195,000	160	21
1956	220,000	176	10
1957	275,000	225	25
1958	323,000*	265	19

* Estimated.

How to Predict Octane Numbers of Multi-Component Blends

Ethyl Research Develops Equations for Calculation of Research and Motor Octane Numbers of Gasoline Blends

Accurate predictions of final blend octane numbers are necessary in any paper study of the refinery gasoline pool.

But linear calculation of final blend octane numbers generally is unsatisfactory. Volumetric average values will be higher or lower because of differences such as antiknock rating, hydrocarbon type, etc., in fuel components.

One common practice has been to introduce a blending factor to correct the final octane number. Generally, this works quite well once a given blending situation has been established.

However, none of the many techniques suggested for predicting blending deviation has proved to be so universally adaptable that it can be relied upon for broad application.

Predicting Blending Deviation by Equation. Ethyl Research has developed equations that are accurate for calculating both Research and Motor octane numbers. These equations may be applied in specific refining situations for both operating and economic calculations, or for wider, industry-type studies.

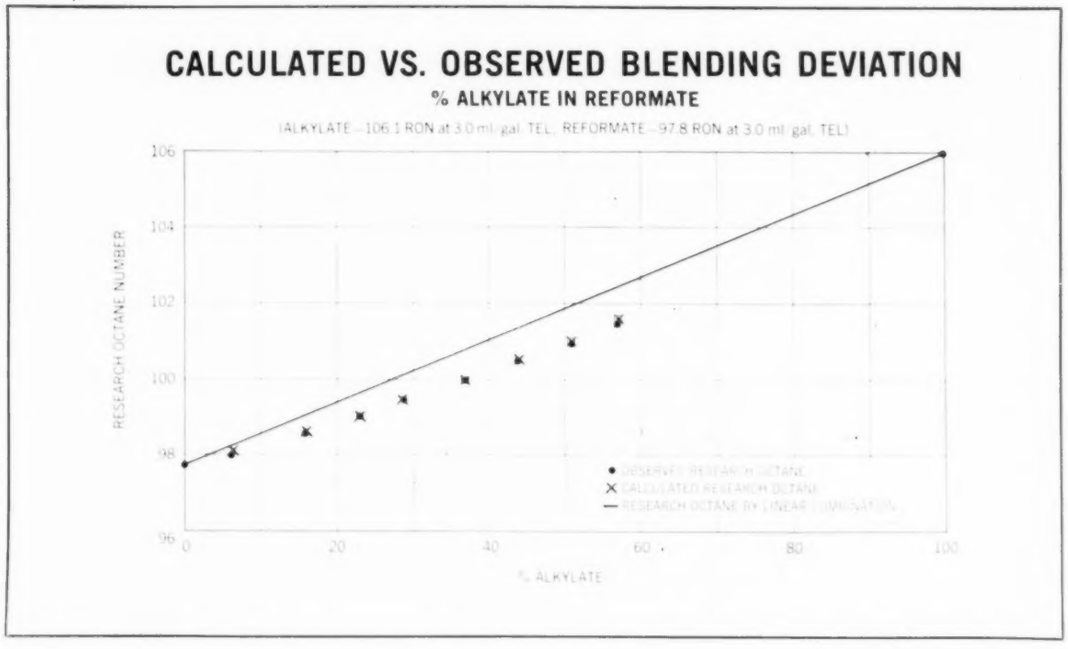
The equations fill the following requirements necessary to a good predicting technique:

They are accurate over a wide range of components and blends, since almost all possible types of gasoline components were included in the study.

They retain simplicity consistent with accuracy.

They are set up to handle different TEL levels.

While the equations were developed for use with high speed computers, they also are suitable for calculation with desk-type machines.



The Research Octane Number Equation

The equation for calculating Research octane is as follows:

$$R = \bar{r} + a_1\left[(\bar{rj}) - (\bar{r})\,(\bar{j})\right] + a_2\left[(\bar{0^2}) - (\bar{0})^2\right] + a_3\left[(\bar{A^2}) - (\bar{A})^2\right]$$

where:

- R = Research octane number of the blend.
- r = Research octane number of each component.
- j = Sensitivity (Research octane number minus Motor octane number) of each component.
- a = Equation coefficient.
- $\bar{r}$ = Volumetric-average Research octane number.
- $\bar{j}$ = Volumetric-average sensitivity.
- $\bar{rj}$ = Volumetric-average of the product of r and j.
- $\bar{0^2}$ = Volumetric-average of the square of the olefin content in volume percent.
- $\bar{0}^2$ = Square of the volumetric-average olefin content in volume percent.
- $\bar{A^2}$ = Volumetric-average of the square of the aromatic content in volume percent.
- $\bar{A}^2$ = Square of the volumetric-average aromatic content in volume percent.

Equation coefficients have been established for use at tetraethyllead (TEL) concentrations of 3.0, 1.5 and 0.0 ml./gallon. Other TEL concentrations may be found by interpolation using TEL susceptibility charts.

A similar equation has been developed for calculating motor octane number.

Scope and Range of Development Data. Equations were developed by the method of least squares from 187 blends covering a wide range of finished gasolines. At each of three TEL levels, 135 blends out of 187 blends were selected for use in deriving and checking the blending equations. Fuels were from 24 refineries representing a good average of all U. S. facilities.

The number of components in the blends varied from 2 to 15. Component properties examined were Research octane number, Motor octane number, sensitivity, olefin content, aromatic content, sulfur content, gravity, and the 50 percent ASTM distillation temperatures.

TABLE 1 **Gasoline Components Represented in Blends Used to Develop Predicting Equations**

Alkylate	Aromatic Concentrate
Butane	Aromatic Raffinate
Catalytically Cracked Naphtha	C_5 and C_6 Isomers
Natural Gasoline	Pentane
Polymer	Reformate
Thermal Reformate	Thermally Cracked Naphtha

Several types of alkylate, reformate, catalytically cracked naphtha and other components were represented.

TABLE 2 **Range of Properties of Blend Components and Blends Used to Develop Predicting Equations**

Properties	Blend Component	Blend Range
Research Octane No.	59-113	85-105
Motor Octane No.	62-107	79-103
Olefin content, Vol %	0-100	0-60
Aromatic content, Vol %	0-96	0-70
Saturate content	0-100	25-86
Sulfur, Weight %	0-0.643	0.01-0.227

How Ethyl Research can help you

The accuracy of predictions can be improved by tailoring these equations to individual refining situations.

Ethyl Refinery Technologists are ready to work with you to establish equation coefficients from your blending data.

For an appointment with one of these specialists, see your Ethyl Representative.

Your Ethyl Representative also can supply you with a detailed engineering report of this study which served as a basis for the presentation, "A New Approach to Blending Octanes" at the New York meeting of the API, Division of Refining.

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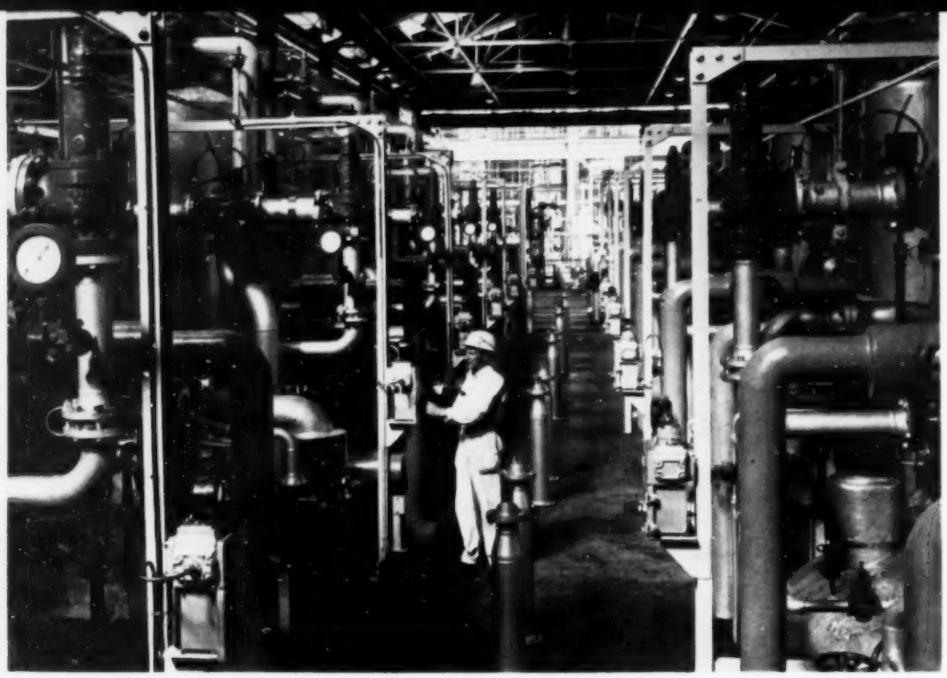


Reactor building at synthetic rubber plant at Fawley (photo courtesy The International Synthetic Rubber Co. Ltd.)

tity converted to other derivative solvents, 40,000 tons; styrene, 40,000 tons; ethyl chloride, 35,000 tons; "Terylene" fiber, 13,000 tons; dichlorethane, 11,000 tons; and aromatics and others, 20,000 tons.

Figures of UK capacity for olefin output from petrochemical plants and refineries supplying for chemical use as at mid-1958 are also estimated as follows: ethylene, 192,000 tons; propylene, 176,000 tons; and butylenes, 97,000 tons. With expansions then known, these capacities were seen as rising to: ethylene, 337,000 tons; propylene, 284,000 tons; and butylenes, 169,000 tons.

The growth in the number of petrochemicals plants operating and their feed stock intakes are shown in Table II. An indication of the rising tempo of activity is also to be seen in the monthly average figures of liquid feed stock delivered from UK refineries for petrochemicals given in Table III.

Although not an organic petrochemical, UK production of carbon-black (including lamp and vegetable black but excluding acetylene and bone black) is reported by OEEC as 104,300 tons in 1957 against 81,900 tons in 1956. Production in the first six months of 1958 was 59,000 tons, 19% more than in the same period of 1957. The OEEC report states that over 95% of UK carbon-black production is now based on petroleum as raw material. No reference is made to the expansion of sulfur output at oil refineries.

As to capital investment in this industry, the total as at December 31, 1957, is now put by OECC as having totaled $212 million, including $24* million in respect of utilities and general facilities, a factor which previously had been excluded from these calculations. It is foreseen that, by end-1960, investment under this head may amount to $400 million.

A leading authority in this field—Dr. S. W. Saunders, chairman of ICI's heavy organic chemicals division—has recently asserted in *Chemical Processing* that "during the past four years capital investment in petrochemical plants has doubled to the present $314 million."

This would appear to be borne out by the following estimates of the growth of capital investment: 1948-43, £39 million; 1948-54, £43 million; 1948-55, £45 million; 1948-56, £61 million; 1948-57, £76 million; 1948-58, £90 million (approx.); and 1948-60, £143 million.

Whatever the degree of accuracy of these very difficult assessments, there is no doubt the UK has the most capital invested in petrochemical plants—as well as the highest production—of any country outside the U.S. No reason is seen by British experts why this virile and still relatively new industry should not continue to expand until something like a comparable position to that the USA reached—where about 90% of all organic chemicals is produced from petroleum.

The notes which follow are confined to projects completed by the various companies in recent months or still current. The main developments last year were reviewed in WORLD PETROLEUM in January 1959.

An exception to the time limitation set to this review must be made in the case of the first large-scale synthetic-rubber plant in the UK, that of *The International Synthetic Rubber Co. Ltd.* at Hythe, Southampton, which reached full-stream production about July 1958—an event which *The Rubber Industry* supplement to *The Times* of April 27 last called "an industrial event of primary importance."

Capital cost was put at about £6 million, subscribed by nine of the leading tire manufacturers in the country, and the plant was designed for the production of 70,000 tons a year of styrene-butadiene rubber (SBR, earlier generally termed GR-S), but it was widely reported as capable of ready expansion to 90,000 tons without under expenditure. Pending completion in late 1958 of Esso Petroleum's new chemicals plant, quantities of butadiene were imported, the styrene being supplied by the Grangemouth plant of Forth Chemicals Ltd. and the Carrington plant of Shell Chemical Co.

According to the above mentioned supplement, the saving which can be attributed to this SBR production is estimated at $30 million a year. Domestic demand is rising, and will probably reach 80,000 tons of synthetic rubber a year in 1963, but at present there is an exportable surplus of about 15,000 tons.

WORLD PETROLEUM was informed by *International Synthetic Rubber Co.* in April that it was receiving all its butadiene requirements from Esso's chemical plant at Fawley by a $1\frac{3}{4}$-mile pipeline, and consumption was in the region of 50,000 tons a year. In May the plant was building up to its capacity rate of 70,000 tons a year and the company was reported in full production of four main types of synthetic rubbers and two main types of lattices, and research was proceeding on the further development of this synthetic field.

The chemical plant of *Esso Petroleum Co.*, opened formally early December last, and the current position is described in a separate article elsewhere in this issue.

TABLE II
OPERATING UK PETROCHEMICAL PLANTS AND FEED STOCKS

Year	Plants Operating Number	Liquid Feed Stock Consumed Tons	Refinery Gases Consumed
1953	5	472,000	84,000
1954	7	549,000	102,000
1955	7	562,000	155,000
1956	8	608,000	162,000
1957	9	859,000	168,000
1958	12	1,038,000	203,000*
1960	15	1,315,000*	

* Estimated.

TABLE III
LIQUID FEED STOCK FOR PETROCHEMICALS FROM UK REFINERIES
(Monthly Average in Tons)

Year		Year	
1953	42,300	1957	66,100
1954	50,600	1958	69,300
1955	47,200	1959	
1956	55,500	(Jan.-Mar.)	72,800

*The report (p. 87) gives "$42" million and (p. 94) "$24." Inquiry reveals that the former should read "$24."

While on the subject of synthetic rubber, it must be recorded that Wm. H. McCoy, managing director of *Du Pont Co. (United Kingdom) Ltd.*, announced in May that his group's first full-scale neoprene synthetic rubber plant outside the USA—on a site of 380 acres near Londonderry (North Ireland)—was approximately a third complete. Barring unforeseen delays, production will start in the first half of 1960. Mr. McCoy said that 87% of equipment and supplies, valued at over £2½ million, have been purchased in the UK alone, the remainder being mostly bought on the continent.

The only indication that has been given as to capacity is that it will be sufficient to supply the requirements of neoprene in the UK, continental Europe, the Middle East, and Africa.

In May, the company opened its new elastomers research laboratory at Hemel Hempstead (Hertfordshire). Its main function will be to find new applications for neoprene and to help customers to use the product successfully.

Imperial Chemical Industries Ltd., in its review of operations for 1958, laid stress on the fact that the former, rather arbitrary, description of large-tonnage products of the chemical industry as "heavy" chemicals is no longer applicable. Whereas these were formerly almost exclusively inorganic substances, today a considerable range of organic chemicals is required in such large quantities as fully to justify the production being called heavy.

In fact, today alkylamines and phenol derivatives are virtually the only products made by the company's newly-formed heavy organic chemicals division which are not derived from petroleum, and the Wilton Billingham petroleum-chemical complex, linked across the River Tees by a 10-mile pipeline system, is claimed to be the biggest European center of such production. Further, it is claimed that the above division carries on about a third of today's UK manufacture of petrochemicals. There is such extensive pipeline transfer of liquids and gases from Wilton to Billingham, and vice versa, that the two centers of production are best regarded as virtually one. The focal point of the complex, however, can be considered from many aspects as the Wilton olefin plant, where a third naphtha cracking unit will come onstream this year.

At this complex a new plant was brought into production in 1958 for the manufacture of nonyl phenol and "Topanol" O, and extensions were made to the methylamine, ethylene oxide, and ethylene glycol plants. During 1959, there will be an extension of the *para*-xylene plant necessary for increased "Terylene" production at Wilton.

New plant to make ammonia from petroleum is being built at Billingham, and an acrylonitrile plant—the first of its kind in the UK—may go into production this year. A 4,000-ton-per-year unit is also being built to meet the increased demand for "Diakon," ICI's acrylic moulding material.

Developments at Heysham are rarely in the news, but it is known that important extensions to the methanol plant were authorized in 1958.

Up to now, all Billingham production of synthetic ammonia and methanol—one of the largest in the world—has been based on coal. The expansion of capacity now being made, however, is being based on fuel oil.

At Wilton, hub of this great complex, there are a number of current major projects to record, and it has been stated recently that, so far, over £100 million have been spent out of the £118 millions capital expenditure authorized.

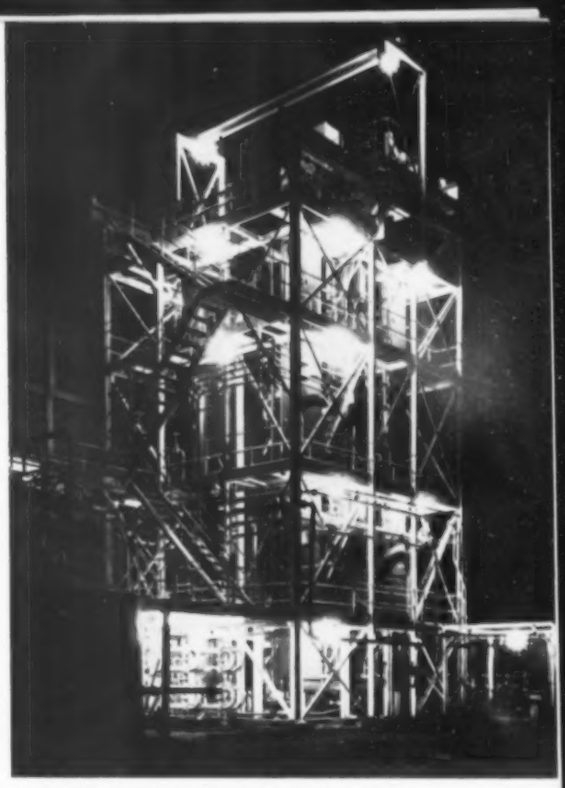
A fourth polythene unit for the manufacture of "Alkathene" is scheduled for completion this year, raising annual output to 90,000 tons from 55,000. Output will thus have been quadrupled since 1951. "Alkathene" is made by polymerizing ethylene by the high-pressure process developed by ICI; and the company asserts that, although types of polythene can be made by low-pressure techniques, these have not notably affected the growth of the market for high-pressure polythene. It is, however, closely studying low-pressure methods in connection with the polymerization of olefins other than ethylene. Research is also proceeding actively on the polymerization of propylene, and the latter is being made in a pilot plant at Wilton.

Quite recently it was announced that polyolefin activities are to be extended by the introduction of a new polypropylene plastic under the name of "Propathene" and that an agreement has been signed for the acquisition of a manufacturing license for this material under the Montecatini and Montecatini-Ziegler British patents. The "Propathene" plant under construction at Wilton will considerably extend the already wide range covered by the "Alkathene" polymers and bring ICI's total polyolefin capacity for "Alkathene" and "Propathene" to over 100,000 tons a year. Though the capacity of the new "Propathene" plant has not been given out by the company, it has been deduced by an authority that it is likely to be of the order of 10,000 tons a year. Meanwhile, pilot plant production of this new plastic was augmented so that commercial quantities could be made available from June 1.

"Terylene" capacity continues to be expanded, and is due to be raised to 30 from 22 million pounds a year in 1959, and to 50 million by 1961. By then, capacity will be over five times that of the original installation.

In 1957, it was announced that a 1,000-acre site had been purchased on the River Severn near Bristol, and that capital investment of about £100 million was envisaged by the mid-1970's for building up another petroleum-chemical complex to be known as the Severnside Works. This "second Wilton" is still at an early planning stage.

The Grangemouth petrochemical complex of *British Hydrocarbon Chemicals Ltd.* (50-50 *British Petroleum* and *The Distillers Co. Ltd.*) continues to be expanded in a virile manner. By 1958, some £20 million had been invested and, with completion of the projects already announced, this capital expenditure will have been raised to around £33 million.



Part of the oil cracking plant at the Spondon Works of British Celanese. Olefins obtained by cracking are absorbed in these towers.

The three companies which form this complex—British Hydrocarbon Chemicals, Forth Chemicals and Grange Chemicals—the last two being two-thirds owned by BHC—are reported to have produced some 200,000 tons of chemical intermediates in 1958. A very much higher level of productivity will become available within a year or so as a result of current project developments.

Late in 1958 saw the start of construction of the third ethylene plant, with completion scheduled for mid-1960. This will have a capacity greater than that of the first and second units combined, and will more than double Grangemouth's capacity for producing olefins. It will also be the largest plant of its kind outside the USA, and is claimed to be considerably bigger than any other so far planned in Europe.

Prior to the commissioning of this third unit, Grangemouth ethylene capacity was around 60,000 tons a year, with the greater part going for the manufacture of industrial alcohol and some to Forth Chemicals for styrene manufacture and to Union Carbide (Gemec Ltd.) at Grangemouth for the production of polyethylene.

The most important point, however, from the aspect of the future of the petrochemical industry in the UK is that the construction of this third unit will not only enable a further development program to be undertaken at Grangemouth, but will also permit existing plants, and the others now constructing, to be operated at full capacity.

A new plant, to produce synthetic phenol by a process developed by Distillers, is under construction, and British Hydrocarbon

Chemicals expects this to be completed within a few months.

Another plant constructing at Grangemouth on which good progress is reported is that for making "Rigidex" polyethylene by the Phillips low-pressure process for which the exclusive UK license is held by Distillers. This thermoplastic will be delivered in pellet form suitable for moulding into finished goods, and the plant is expected to be commissioned in the near future.

It has been stated that petrochemicals now account for some 8% of all "Shell" group sales, and witness to the importance attached to this relatively new development in the total oil and chemical business structure is the recent decision to separate the two for management purposes. Two new companies for petrochemicals have been formed, one in the Netherlands and the other in the UK, to take over certain supply activities and responsibility for advice and services to the operating companies. The two new concerns are N.V. Bataafse International Chemie Mij. in The Hague and Shell International Chemical Co. Ltd. in London.

At Shell Haven, a plant costing over £16½ million to produce 75,000 tons a year of ammonia was commissioned toward the end of May, and should be in full operation by the time this review is published. Some 15,000 tons of this will be used *in situ* for "Nitra-Shell" manufacture. An article describing this plant appears elsewhere in this review.

Fisons Ltd. will take most of the balance as liquid ammonia for use in its new nitrogen plant, which went into production in June at Stanford-le-Hope, adjoining Shell Haven. This will have an output of about 140,000 tons a year of ammonium nitrate for incorporation in Fison's compound fertilizers made in various parts of the country. A technical description of this plant is given elsewhere in this review.

In regard to detergent production it is worthy of note that Shell-Haven now has an annual production rate of some 30,000 tons of premium quality alkylate.

Since *Petrochemicals Ltd.* was acquired by *Shell Chemical Co.* in 1955, the works at Corrington (previously known as Partington) have gradually become the center of considerable expansion as a petrochemical complex. Though details have still to be announced, it is known that much general development is planned and considerable capital expenditure envisaged over the next few years.

Even so, several important new projects have been announced in recent months.

Work is now proceeding on a styrene monomer plant with a capacity of 18,000 tons a year, but no details are available.

To meet the increasing demand for ethylene derivatives, the Carrington works is being expanded to include facilities for increasing the production of ethylene oxide by direct oxidation. This will raise plant output of this chemical to 45,000 tons annually from 25,000; and it is stated that, when the plans envisaged are completed, the works will produce about a third of Europe's known requirements of ethylene oxide.

Work is also proceeding at Corrington for, initially, about 30,000 tons a year of polyolefin manufacturing facilities under Shell's exclusive license for the Ziegler process, with completion due by 1961. Eventual output is expected to be 45,000 to 50,000 tons partly polyethylenes and partly polypropylenes, including high-density polyethylenes. It may be noted that manufacture of low-pressure polyethylene by this process started on a pilot-plant scale in 1957.

To improve processing facilities in general at Carrington, four 23-mile underground pipelines are being laid from the Stanlow refinery. Work has started at both ends, and this £1 million project is due for completion by end-1959. These lines will not only enable feed stock for the cracking plant to be supplied more economically than the previous barge transportation, but will also cater for the higher volume requirements of the future.

Styrene Products Ltd.—A subsidiary acquired when Petrochemicals Ltd. was taken over by Shell—has now become the largest UK producer of expanded polystyrene. Late 1958 saw the opening at Carrington of a plant to produce over 4,000 cu ft per day of this product by a continuous moulding process. This is expected to find a large outlet in insulating in many directions under the name "Styrocell." The company also manufactures a wide range of "conventional" polystyrenes."

As long ago as 1938, *British Celanese Ltd.* (merged with Courtauds in 1957) had developed a process for making both ethanol and isopropanol and, from these, acetic acid and acetone based on the thermal cracking of oil for ethylene and propylene. Both the latter are important raw materials for the company's cellulose acetate flake, plastic, and yarn. The installation of a cracking plant at Spondon, near Derby, which went into operation in 1942, was the result of the top priority given to it by the government—because this alternative source of alcohols, being derived from oil, was more secure than the previous production based on molasses. Thus the British Celanese plant was the first in the UK to produce alcohols and petroleum-chemicals by oil cracking.

Plant capacity figures have never been given, but it has been announced that between 1947 and October 1958 the output had been trebled and the range of petrochemicals considerably increased. By then, in addition to acetic acid and acetate, the range included vinyl acetate, hydrocarbon resin, butadiene, ethers, and aromatic hydrocarbons. End-1958 saw plant capacity again being expanded, this time by 40% and extensive automatic control and recording apparatus being incorporated.

British Celanese claims its process to be unique, particularly in its remarkably high yield of useful products—especially ethylene, propylene, and butadiene—and to differ in a number of important respects from the USA steam-cracking method which is being operated in the UK by later entrants to the field of petrochemicals. The company has also recently completed extensions of its methyl cellulose production capacity.

The petrochemical interests of *Monsanto Chemicals Ltd.* have until recently been mainly centered in its one-third interest in Forth Chemicals Ltd. This was formed jointly with British Hydrocarbon Chemicals Ltd. (British Petroleum) to product monomeric styrene in a plant adjacent to the Grangemouth BP refinery for use in the manufacture of polystyrene. Recent activity has been concerned mainly with the development of new grades of toughened material.

Monsanto's greatest stake in the petrochemical field today, however, is at Fawley, where a plant adjoining the Esso refinery costing £3¼ million was commissioned this spring. This is now producing high-pressure polyethylene plastics in film and moulding grades at an initial rate of 10,000 tons a year. The raw material is ethylene supplied from Esso's new chemicals plant, and it is reported that further expansion of the polyethylene plant has already begun.

Union Carbide Ltd. (through Gemec Ltd.) has two centers of petrochemical production, both of which are in active expansion. At Fawley, a £3 million ethylene-oxide and derivatives plant is expected to come into operation by the end of this year with a production capacity of 45 million pounds a year. Ethylene gas will be piped direct from the adjacent Esso chemicals plant, and ethylene oxide will be produced by direct oxidation for use as base material for ethylene glycol and other derivatives.

At Grangemouth (Scotland), high-pressure polyethylene only became available last year, but already the company has announced plans to double production. The existing facilities are being augmented by another unit scheduled to produce 30 million pounds a year, with completion due about end-1960. This latest expansion represents the sixth major investment by Union Carbide Corp. in the European petrochemical field.

As to the future, Dr. Saunders of ICI may be quoted again: "There are two directions in which a switchover from coal as basic raw material has not yet developed," he said. "First, practically all production of acetylene and aromatics still comes from coal. There is also one potential but undeveloped method of supply of petroleum raw materials—the imports in refrigerated tankers of liquefied C_1 to C_4 hydrocarbons. The next 5 to 10 years should show whether economic progress can be made in these directions. If so, petrochemical activities in the UK will be as comprehensive as in any country in the world."

At least, already, apart from representing one of the most rapidly expanding sectors of British industry and saving considerable dollar expenditure, within the short space of a decade petrochemical development is providing a valuable new export trade. A rate of £30 million a year has been reached to date, and it is destined to reach a much higher figure. END

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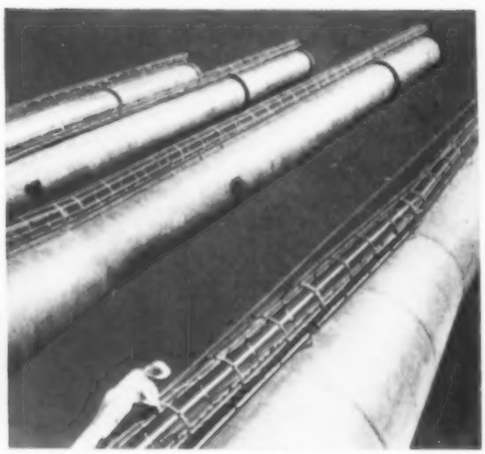

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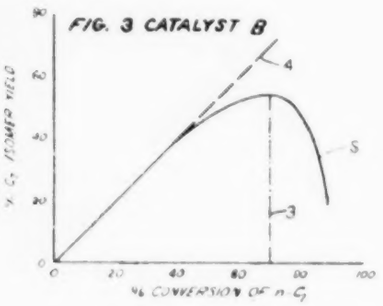
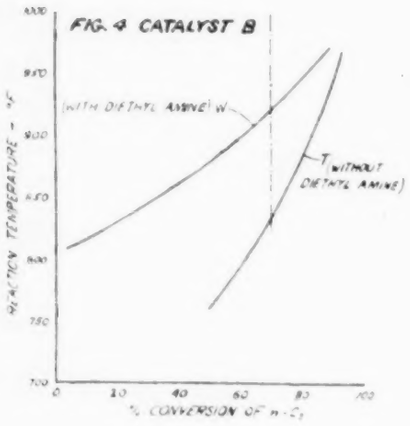
Annual review of USA patents on petroleum refining and processing

by Heinz Heinemann and P. A. Lefrancois

Figs. 3 and 4 Effect of nitrogen compounds on isomer yield during catalytic reforming: USA Patent 2,849,377, H. B. Ogburn et al. (to The Atlantic Refining Co.)





THE major change made in this year's review is the omission of all patents pertaining to catalyst manufacture and regeneration. The number of patents on catalysts has become so large that it could not be treated within the scope of this review. Two separate patent digests on catalysts have appeared during the past year (in the November 1958 and June 1959 issues of WORLD PETROLEUM).

Even though a large segment of the pertinent patent literature was thus omitted from present consideration, close to 500 patents had to be studied for the selection of the 175 which are reviewed here. It is obvious from these figures that patents of interest to the petroleum refiner have continued to become more numerous. It is equally obvious to the reviewers that no major new process possibilities have been patented. There are many worthwhile and ingenious improvements, but one fails to see development of a new processing art since the advent of catalytic reforming and hydrogen treating. As a trend, the increasing attention given to catalytic isomerization, particularly of low boiling hydrocarbons, is important. Not only are there more new patents in this field, but the assignees represent a larger spectrum of the refining industry.

ISOMERIZATION: The number of paraffin isomerization patents issued during the past year, while still small, has increased markedly over the preceding years. This reflects the increasing importance attached to isomerization as a means of increasing gasoline octane number.

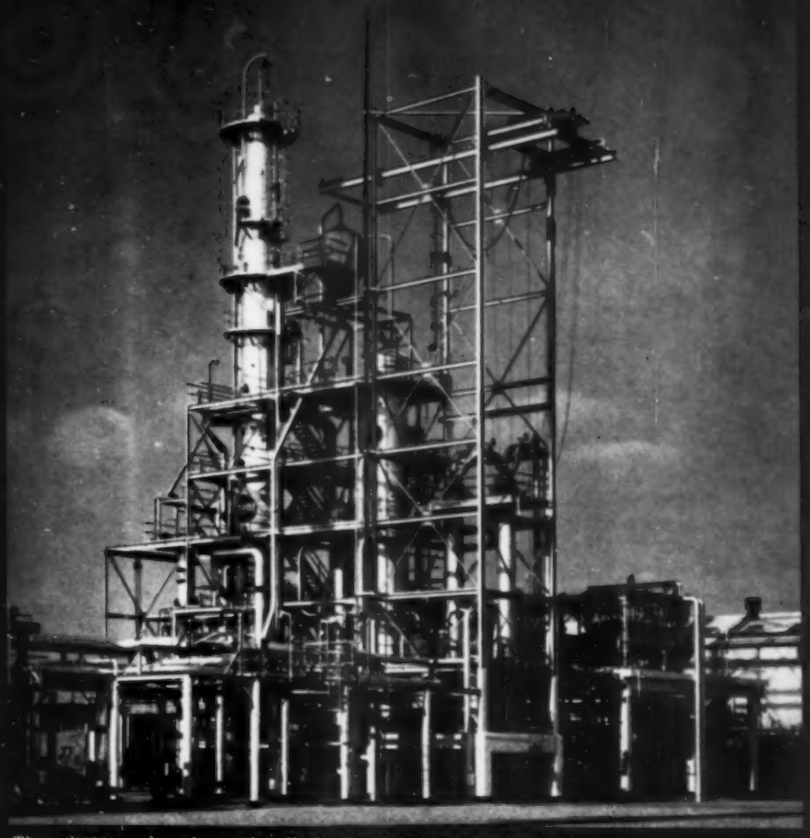
H. G. Boynton and J. T. Horeczy (2,847,488 to Esso Res. & Eng. Co.) isomerize n-butane with supported aluminum chloride and hydrolyze alkyl chlorides in the product with aqueous sodium hydroxide at 290-500° F. A two-stage process employing $AlCl_3$-HCl hydrocarbon liquid complex as a catalyst is disclosed in Phillips Petroleum Co.'s 2,782,244 (L. E. Drehman). Catalyst is the continuous phase in the first, hydrocarbons in the second stage. Isomerization of 1-olefins to 2- olefins by hydrofluorination and dehydrofluorination is the subject of D. H. Belden's 2,804,490 (to Universal Oil Products Co.).

N. C. Carter and J. S. Cromeans (2,805,269 to Phillips Petroleum Co.) separate methylcyclopentane and aromatics from C_6 and C_7 paraffins. These are then isomerized at 815-860° F. and 250-550 psig. over molybdenum oxide on alumina or on silica-alumina. Hydroisomerization over molybdena on silica stabilized alumina is also disclosed by J. B. McKinley and W. A. Horne in Gulf Res. & Dev. Co.'s 2,864,875. Reaction temperature is 850-1100° F. and hydrogen containing 0.0023-0.03% oxygen is employed.

In M. W. Kellogg Co. patent (2,834,823, J. L. Patton, G. W. Stanford and W. P. Burton) isomerization of C_4-C_6 hydrocarbons over a platinum-alumina catalyst is described. Conditions are 750-850° F., 150-300 psig., and 0.5-4 wt. wt. hr. space rate. W. C. Starnes and R. C. Zabor according to Gulf Res. & Dev. Co.'s 2,831,908, isomerize C_5 paraffins with platinum-alumina at 600-900° F., 50-500 psig. and relatively high space rates, e.g. 8v. v. hr. G. Holzman and G. M. Good (2,841,626 to Shell Dev. Co.) add 2-100% steam to C_4-C_6 hydrocarbons during isomerization over platinum-alumina-halogen catalyst. The catalyst must contain less than 0.1% halogen. Selectivity is improved. A combination isomerization and reforming process is claimed by V. Haensel in Universal Oil Products Co.'s 2,871,277. L. H. Beckberger in Sinclair Refining Co.'s 2,862,872 combines C_4-C_6 paraffin isomerization with second stage dehydrogenation of unconverted n-butane.

Production of p-xylene from m- and o-xylene rich fractions by isomerization over silica-alumina at 700-1000° F. is proposed in California Research Corp.'s 2,837,581 and 2,837,582 (R. W. Hill, R. V. Luthy and A. J. Engel).

ALKYLATION: Alkylation is increasing in importance as a refining method providing



The photographs show the Hydrodesulphurisation Unit at Shell's Stanlow Refinery and are by courtesy of the Shell Petroleum Co. Ltd.

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high octane motor fuels. While no essentially new processes have been proposed recently, the number of patents on the subject has increased sharply; apparently much thought is being given to improve existing processes.

Several patents refer to the HF alkylation process. D. H. Belden (2,832,812 to Universal Oil Products Co.) improves alkylate octane number by hydrofluorination of olefins in the feed prior to alkylation. J. E. Penick and C. C. Stapleford (2,817,692 to Socony Mobil Oil Co.) improve the HF tower design by providing a HF saturator zone below the reaction zone. Another reactor design, which minimizes residual fluoride in the hydrocarbon product is proposed by C. H. Owen (2,855,449 to Phillips Petroleum Co.). Feed preparation to an HF alkylation is the subject of M. P. Matuszak's 2,826,620 (to Phillips Petroleum Co.). Butene-1 content of the feed is reduced by polymerization with the Phillips polyolefin catalyst.

A large number of patents assigned to the M. W. Kellogg Co. is concerned with sulfuric acid alkylation. 2,828,348 (S. R. Stiles and J. Warburton) proposes means of drying recycle isobutane. 2,829,181 (S. R. Stiles and A. R. Johnson) relates to the use of autorefrigeration. In 2,829,183 S. R. Stiles describes means to effect a better separation of hydrocarbons from an acid rich phase. According to 2,831,043 (S. R. Stiles) sulfuric acid is crystallized by vaporization and condensation of hydrocarbons and melted crystals are reused in the alkylation step. Patents 2,859,259 and 2,859,260 (S. R. Stiles) deal with a reactor design, permitting intimate mixing of olefins and acid. A reactor, disclosed in Stiles' 2,852,851 is designed to cut down on vapor carryover. C. C. King's 2,829,182 concerns removal of diolefins and acetylenes from alkylation feed. This is accomplished by polymerization over copper pyrophosphate at 200-450° F. and at 10-250 psi.

Typical of work on the alkylation of aromatics are the following four patents. C. B. Scott, W. D. Schaeffer and J. D. Wordic (2,810,002 to Union Oil Co. of Cal.) treat xylenes with aluminum chloride and cadmium chloride to separate m-xylene from isomers. H. R. Appell (2,842,602 to Universal Oil Products Co.) proposes an alkylation catalyst consisting of $AlCl_n(R)_{3-n}$, where R is $-SO_3F$, $-PO_2F_2$, or $-HPO_3F$. In another U.O.P. patent (2,860,173) E. K. Jones and D. D. Dettner claim the manufacture of isopropyl benzene by alkylation over a solid phosphoric acid catalyst, the state of hydration of which is carefully maintained. K. M. Thompson (2,875,257 to The Atlantic Refining Co.) purified crude alkylated aromatic products by a mild sulfuric acid treatment at 60-160° F. with 78-99% H_2SO_4.

H. Heinemann (2,866,837 to Houdry Process Corp.) proposes a dual functional platinum containing catalyst for alkylation at 800° F. and 200 psi. According to J. T. Kelly and H. M. Knight (2,824,146 to the American Oil Co.) isobutane and ethylene can be alkylated over a metal pyrophosphate hydrate in the presence of boron trifluoride.

CATALYTIC REFORMING AND DEHYDROGENATION: a. *Reforming*—Against expectation there has been an upswing in the number of patents in this area. Most of these deal with refinements and modifications of existing procedures. A large number of reforming catalyst patents have been discussed in earlier reviews (Nov. 1958, June 1959) and are not considered here. The 35 patents abstracted below are a selection from about 150 which have been reviewed.

A two stage reforming process, using platinum alumina catalyst in the first and chromia or molybdena alumina in the second stage is disclosed in Sinclair Refining Co.'s 2,849,376 (K. M. Watson). Conversion in the first zone is limited to a maximum octane number of 75-85. G. W. Stanford and J. L. Patton (2,734,718 to The M. W. Kellogg Co.) describe a combination reforming and desulfurization process, utilizing hydrogen produced during reforming in the desulfurization stage. In another M. W. Kellogg Co. patent (2,860,102 M. F. Nathan) a method for substantially reducing catalyst losses in a fluid bed platinum catalyst system is suggested. J. K. Roberts (2,853,436 to Standard Oil Co., Indiana) reforms with four or five reactors in series. There are two reactors in parallel at the end of the series. Operating conditions are such that only the last reactor in series has to be regenerated. A. B. Welty, Jr., W. O. Taff, D. D. Mac Laren and E. J. Gornowski (2,856,351 to Esso Res. & Eng. Co.) discuss a method of operating a fluid bed platinum reforming process at 50 psig. pressure, while recycling as little as 200 cu. ft. of hydrogen/bbl. of oil. According to another Esso patent (2,842,482) A. Voorhies, Jr. and R. C. Morbeck carry out a fluid bed molybdena reforming process in the substantial absence of water.

K. M. Elliott (2,870,083 to Socony Mobil Oil Co.) combines advantages of low pressure reforming with the advantages of high pressure reforming by operating at high reactor pressure and low hydrogen partial pressure.

Factionation of naphtha into lower and higher boiling fractions is proposed in Sun Oil Co.'s 2,867,576 (E. M. Honeycutt). The higher boiling fraction is reformed, paraffins are separated from reformate and blended with the lower boiling fraction. The mixture is then reformed at more severe conditions

Fig. 1 Separation of aromatics and aliphatics with ethylene carbonate: USA Patent 2,837,585, J. V. Murray, Jr., et al. (to Union Carbide Corp.).

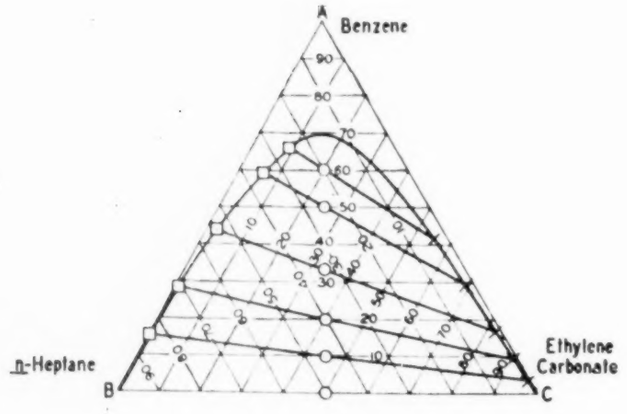
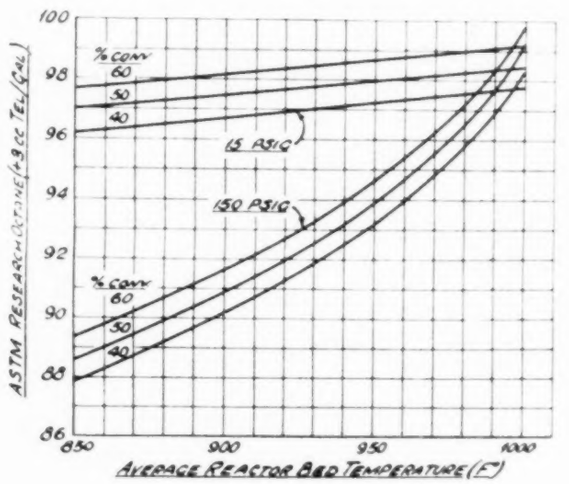


Fig. 2 Catalytic cracking at elevated pressure: USA Patent 2,850,348, A. R. Vander Ploeg et al. (to The Texas Co.).



than prevail in the first reforming zone. H. Heinemann (2,866,745 to Houdry Process Corp.) fractionates reformer feed into lower and higher boiling fractions which are then reformed under conditions of different severity. According to V. Haensel (2,853,437 to Universal Oil Products Co.) reformate is extracted to separate paraffins. Light paraffinic naphtha is recycled to reforming with a heavy straight run fraction. Heavy paraffinic naphtha is separately charged to reforming with a light straight run naphtha.

K. K. Kearby and I. Kirshenbaum (2,866,747 to Esso Res. & Eng. Co.) improve a reforming operation over platinum catalyst by minimizing the amount of water present on the catalyst and by pretreating the catalyst, following regeneration, with a C_1-C_4 hydrocarbon. I. G. Nixon (2,847,363 to Shell Dev. Co.) enhances aromatization of naphthenes over acidic platinum catalysts by adding 25-70% of n-pentane to the feed. The conversion of methylcyclopentane in naphtha to benzene is the subject of Standard Oil Co., Indiana's patent 2,861,944 (J. R. Coley, B. L. Evering and J. D. McCollum). Reaction is at 900-950° F. and 50-150 psi over supported platinum in the presence of 100-500 ppm. sulfur. G. R. Donaldson and V. Haensel (2,872,492 to Universal Oil Products Co.) prevent the conversion of C_5 ring naphthenes to aromatics during catalytic reforming by addition to the feed of a small amount of an aliphatic amine.

Reforming feed preparation is the subject of the next three patents. P. Urban and R. B. Thompson (2,867,577 to Universal Oil Products Co.) treat an arsenic containing feed with an organic nitrogen compound, having three attached groups and an unshared pair of electrons. H. S. Seelig and A. A. Brooks (2,856,347 to Standard Oil Co., Ind.) hydrogenate reformer feed at 600-800° F. over spent platinum-alumina catalyst. Reactor effluent containing water and hydrogen sulfide is passed over lime, which removes 80% of the water vapor and all of the H_2S at 700° F. J. A. E. Moy (2,852,442 to British Petroleum Co.) extracts aromatics from reformer feeds with liquid sulfur dioxide.

The following group of patents deals with catalyst handling and behavior in reforming systems. A blocked out regeneration system for platinum-alumina catalyst, requiring a low investment is discussed in R. J. Hengstebeck's 2,873,176 (to Standard Oil Co., Indiana). R. W. Sage (2,863,822 to Esso Res. & Eng. Co.) makes up chlorine losses of the catalyst in a series of fixed bed reactors by rotating the sequence of reactors. Each reactor in turn becomes the first in series. It then retains halogen from the halogen content of the feed and the recycle gas. R. M. Love (2,870,085 to Esso Res. & Eng. Co.) has found that the simultaneous presence of hydrogen and carbon dioxide is deleterious to the activity at high temperature of supported platinum catalysts. Simultaneous presence of these gases is avoided by a specified sequence of operations. G. R. Donaldson (2,838,446 to Universal Oil Products Co.) reforms a high nitrogen content feed until substantial catalyst deactivation occurs. Low nitrogen feed is then introduced and processed until considerable catalyst recovery has occurred. H. B. Ogburn, R. D. Bent and G. P. Masologites (2,849,377 to The Atlantic Refining Co., see accompanying graphs) increase the isomerization and aromatization activity of a partially deactivated platinum-silica-alumina catalyst by adding a small amount of an ammonia producing nitrogen compound to the feed.

Several patents deal with reactor design. D. K. Mac Queen (2,813,138 to Phillips Petroleum Co.) describes a reactor, while W. E. Askey and R. M. Love (2,866,744 to Esso Res. & Eng. Co.) have a special reactor arrangement for regenerative operation. Compressor control means are discussed in R. J. Hengstebeck's 2,849,379 (to Standard Oil Co., Indiana). According to Esso's 2,847,360 (C. E. Hemminger, H. Z. Martin, W. S. Rich and E. J. Gornowski) a fluid hydroforming process is carried out in a single staged reactor with baffles extending across for the purpose of obtaining higher temperatures in the lower zones and successively lower temperatures in higher zones.

Heat transfer is important in reforming. A. B. Welty (2,846,364 to Esso Res. & Eng. Co.) describes an improved method to employ shot to supply heat requirements in a fluid bed hydroforming process, using a platinum catalyst. In the same Company's 2,846,366 K. E. Draeger and J. F. Ross, inert shot is segregated in the reactor as well as the regenerator and heated shot is recycled separately to the reactor. An inert heat transfer system is also disclosed in Esso's 2,854,402 (W. A. Rex).

b. *Dehydrogenation*—P. B. Murray (2,856,441 to Sun Oil Co.) dehydrogenates hydrocarbons at 900-1200° F. in the presence of 200 mol. % sulfur dioxide, 5-100% ammonia and an alumina catalyst. R. P. Sieg and L. G. Horn (2,831,041 to California Research Corp.) disclose a butane dehydrogenation process in which the catalyst bed is substantially free of an inert heat retention medium. The catalyst must have high surface area, and contain sorbed oxygen. In California Research Corp.'s 2,831,042 (R. P. Sieg) C_3-C_5 paraffins are contacted in a primary zone with catalyst at 1000-1200° F. and 5-20 inches Hg. Diolefin containing product is mixed with superheated steam and contacted in a second zone with a water gas active dehydrogenation catalyst at 1050-1300° F.

Acetylene production is the subject of 2,838,584 (S. T. Tsutsumi and T. Tomonari to Kurashiki Rayon Co.). Saturated hydrocarbons boiling at 175-350° C. are passed over copper, nickel or chromium catalyst at 700-900° C. Olefin rich gas is then contacted with molybdenum at 1000-1100° C.

DESULFURIZATION AND SWEETENING: While there continue to be quite a few patents on desulfurization, the number has not changed materially from year to year and no new breakthroughs seem to have been accomplished in this field.

a. *Hydrodesulfurization*—Use of a cobalt-molybdena-alumina catalyst promoted with 0.1-6% fluorine is discussed in British Petroleum Co.'s 2,852,437 (F. W. B. Porter and E. C. Housam). In another British Petroleum Co. patent (2,830,013) R. P. Northcutt and E. C. Housam carry out an autofining operation with a fluorine promoted cobalt-molybdena-alumina catalyst which does not exceed $\frac{7}{32}$" size. H. A. Holcomb and M. R. Morrow in Esso Res. & Eng. Co.'s 2,865,850 add 1-10 mol % hydrogen sulfide to the hydrogen stream during desulfurization of a naphtha over a molybdena catalyst. A sequence of steps in the desulfurization of a 400-1000° F. hydrocarbon fraction is disclosed in Union Oil Co. of California's 2,844,517 (T. V. Inwood).

Naphtha hydrodesulfurization with a cobalt or nickel, molybdena or chromia on alumina catalyst and preparation of the catalyst are the subjects of P. G. Nashin in 2,867,581 (to Union Oil Co. of Cal.). W. J. Zimmerschied and P. N. Rylander (2,866,751 and 2,866,752 to Standard Oil Co., Ind.) disclose a novel hydrodesulfurization catalyst compromising nickel metatitanate. Another new catalyst, described by A. Gislon and A. M. Valet (2,853,429 to Compagnie Francaise de Raffinage) is prepared from molybdena or tungsten oxide, nickel or cobalt oxide, magnesia and aluminum powder. The mass is treated with hydrogen peroxide, extruded, dried and reduced.

Desulfurization of heavy residua with a boron trifluoride coordination complex is claimed by Chyn duog Shiah in 2,834,717. F. W. B. Porter and R. P. Northcutt in 2,830,938 (to British Petroleum Co.) use coke oven gas as a source of hydrogen for direct desulfurization over cobalt molybdena alumina.

b. Sweetening—A method of decreasing sweetening time in Doctor treating is disclosed by M. L. Kalinowski in Standard Oil Co. of Indiana's 2,871,187. C. D. TenHave and W. J. Pieters in Shell Dev. Co.'s 2,862,878 describe regeneration of an alkali metal hydroxide, alkali metal phenolate solution which gets diluted with water from the reaction. C. O. Petty (2,862,804 to LaGloria Oil & Gas Co.) claims a process for sweetening and stabilizing hydrocarbons with an organic epoxide and an aqueous alkaline phenol.

Sour hydrocarbons can be sweetened according to R. Miller (2,856,352 and 2,856,353 to Americal Development Co.) by treatment with alkali ferricyanide or ferrocyanide solutions. The alkaline solution is regenerated by electrolytic oxidation.

R. G. Bowers (2,853,431 to Sun Oil Co.) reduces the mercaptan content of straight run gasolines by adding slop oil, N,N'-dialkyl-p-phenylene diamine and a small amount of aqueous ammonia. A new inhibitor, which prevents peroxidation during caustic scrubbing for sweetening cracked gasolines is disclosed in Union Oil Co. of California's 2,835,564 (C. S. Coe). It comprises 3,3',5,5'-tetra (tert. butyl)-4,4' dihydroxy diphenyl.

G. H. Meguerian and W. P. Fairchild (2,848,374 to Standard Oil Co., Indiana)

claim a sweetening process involving treatment with caustic, water soluble alkylene polyamine and copper-polyamine complex.

CRACKING: Many new patents have issued in this area, which is about equal in size to catalytic reforming. While design, operational and coking patents constitute the bulk of the literature, it is noteworthy that there appears to be increasing interest in hydrocracking.

a. *Mechanical and Design Patents*—A heat balanced catalytic cracker is described in C. A. Rehbein's 2,827,422 (to Shell Dev. Co.). Design of a moving bed unit for catalytic or non-catalytic operation is the subject of Socony Mobil Oil Co.'s 2,846,367 (P. P. Lifland). In another moving bed design (2,846,368 to Socony Mobil Co.), J. W. Payne avoids substantial temperature gradients across the moving contact mass. F. F. A. Braconier and A. H. A. Delsemme (2,822,411 to Soc. Belge d'Azote) disclose the design of a hydrocarbon pyrolysis reactor for acetylene manufacture.

T. F. Loughry and R. M. Escott (2,867,512 to Surface Combustion Corp.) have designed a pebble heat exchange unit, while R. L. McIntire (2,843,532 to Phillips Petroleum Co.) describes a pebble heater for a pyrolysis process. A novel fluidized solids cooling system, particularly for use in a steam cracking process, is proposed in Esso Res. & Eng. Co.'s 2,847,366 (W. W. Boisture). T. M. Engle (2,875,147 to Hydrocarbon Research, Inc.) discusses a process of treating hydrocarbon residue with fluid particles and regenerating the latter in one vessel.

b. *Feed Preparation*—C. K. Viland (2,844,520 to Tidewater Oil Co.) claims improved yields and quality from the catalytic cracking of oils low in non-basic nitrogen compounds, by adding 0.1% indole or other non-basic nitrogen compound to the feed. T. M. Pratt (2,834,714) prepares a cracking feed from topped crude, vacuum tower overhead and solvent decarbonized bottoms. L. C. Gutberlet and M. J. den Herder (2,871,185 to Standard Oil Co., Indiana) remove metals from reduced crude by mild coking in the presence of 0.01-5% ethyl-ortho-silicate.

c. *Cracking Operation*—A cracking unit with two regenerative furnaces in series is described in Phillips Petroleum Co.'s 2,875,-148 (R. C. Scofield). Feed is passed through the first and at point of incipient cracking, cold feed is added. The mixture is cracked in the second furnace, operating at lower temperature. A method of cracking a nickel contaminated feed stock is disclosed by E. A. Kelso in Esso Res. & Eng. Co.'s 2,850,-437. A controlled amount of carbon is left on the catalyst leaving the regenerator. C. E. Jahnig (2,846,360 to Esso Res. & Eng. Co.) proposes a fluidized solids method of converting heavy petroleum residue at 1200-2000 F. to useful products. In a group of additional Esso patents: F. H. Blanding and W. J. Schmidt (2,844,518) provide a formula to determine the minimum amount of recycle to obtain improved operation; C. E. Jahnig, F. T. Barr, and J. W. Brown (2,852,-439) integrate fractionation fluid coking and catalytic cracking; E. A. Kelso (2,831,800) adds a second small regenerator to a conventional cracking unit, to burn off carbon to 0.1%.

Catalytic cracking at 150-200 psig. and 975-1100°F. in an otherwise conventional fluid bed unit is proposed by A. R. van der Ploeg and S. P. Dickens (2,856,348 to The Texas Co., see accompanying graph). A. H. Schutte (2,846,373 to The Lummus Co.) introduces liquid phase, heated hydrocarbon oil into a moving bed. E. L. Claridge (2,868,-717 to Shell Dev. Co.) flashes hot petroleum residue and contacts the vapors with a slurried cracking catalyst.

A thermal cracking process, employing a hydrogen donor is disclosed in Gulf Research & Dev. Co.'s 2,865,836. Esso Research & Eng. Co.'s HDDC process is the subject of several patents, such as 2,862,870 (A. Voorhies, Jr.) and 2,843,530 (A. W. Lange, G. G. Wavless and C. S. Carlson).

J. H. Shapleigh (2,830,880 to Hercules Powder Co.) cracks sulfur contaminated oils in the presence of steam to produce hydrogen. The production of aromatics and unsaturated hydrocarbons is the aim of Esso's 2,852,440 (B. I. Smith and E. D. Boston). High temperatures are employed. J. D. Kemp and R. P. Sieg (2,847,358 to California Research Corp.) convert wax into lubricating oil over a mixed vanadium plus molybdena or alumina catalyst in the absence of hydrogen.

Cyclohexene is produced from phenylcyclohexane over an aluminous siliceous natural clay, according to L. C. Fetterly (2,839,590 to Shell Dev. Co.). Temperatures employed are 350-650°C.

d. *Coking*—The majority of patents in this area are assigned to Esso Res. & Eng. Co. The following are typical. J. F. Moser in 2,854,397 describes a fluid coking process in a plurality of separate coking zones with residual oil charge to each zone. In 2,865,840 Moser provides for better separation of gas oil from bottoms. An improved design for a coking vessel is revealed in 2,849,384 (A. Voorhies, Jr. and E. W. S. Nicholson). In 2,848,381 E. W. S. Nicholson is concerned with gas-solids separation in high temperature coking. J. F. Moser (2,847,357) converts residues to maximum amounts of middle distillates by a two-stage fluid coking process. The preparation of "seed coke" is the subject of E. Jahnig's 2,846,374. R. M. Hill and A. W. Langer, Jr. (2,843,529) describe a combination of fluid coking and hydrogen donor diluent cracking. C. N. Kimberlin (2,824,046) uses a dense bed of inert solids for the cracking of heavy residual oils to lower boiling hydrocarbons and coke.

A multistage process for the production of gasoline from petroleum residues is described in Shell Dev. Co.'s 2,871,184 (F. Kunreuther).

e. *Hydrocracking*—P. C. Keith (2,853,433 to Hydrocarbon Research, Inc.) discloses a two-stage process, operating at 900-1050°F. and 35-200 psig. In the same Company's 2,861,943 J. A. Finneran and F. B. Grosselfinger present the design of a two-zone single hydrocracking reactor. The upper zone provides a fluidized hydrocracking, the lower a regeneration and hydrogen production chamber.

R. M. Kennedy and A. E. Hirschler (2,858,267 to Sun Oil Co.) hydrocrack at 795-935°F., 500-1500 psi over a silica alumina catalyst containing 2.9-11% molybdena and 6-20% chromia. E. R. Boedecker and S. G. Hindin (2,862,874 to Houdry Process Corp.) utilize a deactivated silica-alumina catalyst, containing 0.3-1 wt.% of group VI or VIII metal oxides.

Low temperature hydrocracking at above 250°F. and at 100-10,000 psi is discussed in Universal Oil Products Co.'s 2,865,841 (J. Hockstra). The catalyst is a composite of aluminum, aluminum chloride, titanium chloride and hydrogen chloride.

P. B. Weisz (2,854,401 to Socony Mobil Oil Co.) proposes hydrocracking with a physical mixture of catalyst particles, one component of which comprises platinum on an inert carrier, the other an acidic cracking catalyst. According to Esso Res. & Eng. Co.'s 2,859,169 (C. B. Herman) hydrocracking can be carried out with a hydrogen donor precursor, using a hydrogenation catalyst.

REFINING: A large number of patents on separation processes were issued last year as in previous years. Only a few are treated here. Feed preparation for catalytic processing and stabilization of fuels are other subjects in the "refining" category.

a. *Separation*—Separation of meta xylene from a C_8 hydrocarbon mixture is described in C. B. Linn's 2,833,836 (to Universal Oil Products Co.). R. A. Gardner and C. W. Seelbach (2,852,578 to Standard Oil Co., Ohio) separate m-and p-xylene by liquid thermal diffusion. A cyclic adsorption process for the separation of hydrocarbons into aromatic and saturated fractions is the subject of Sun Oil Co.'s 2,856,444 (A. W. Pollock). G. R. Brown, H. A. Strecker and R. R. Crawford (2,874,116 to Standard Oil Co. of Ohio) enrich aromatics in hydrocarbons by selective extraction with a mixture of diethylene glycol and phenyl ethanolamine. R. N. Fleck (2,842,484 to Union Oil Co.) uses a mixed solvent of an aliphatic dinitrile and a mononitrile or monoamine in extractive distillation to separate pure naphthenes, pure paraffins and aromatics. The use of ethylene carbonate and propylene carbonate as selective solvents for the separation of hydrocarbons into three fractions is proposed by J. V. Murray, C. H. Young and J. R. Anderson (2,837,585 to Union Carbide & Chemical Co., see accompanying diagram). The fractions are: 1) aromatics with short side chains, 2) aromatics with longer side chains, 3) non-aromatics. According to Esso Res. & Eng. Co.'s 2,866,835 (C. N. Kimberlin and W. J. Mattox), the separation of straight chain paraffins from straight chain olefins can be accomplished with molecular sieve zeolites. C. L. Thomas (2,865,970 to Sun Oil Co.) separates unsaturates from saturates with a solid anion exchange complex. A. Cham-

(Continued on page 118)

Melzo, Italy. Time to start work for Renato Raggi, owner of a BP Petrol Station. By the end of this year —BP's first year in Italy—some 1500 BP stations will be in operation along Italian roads.

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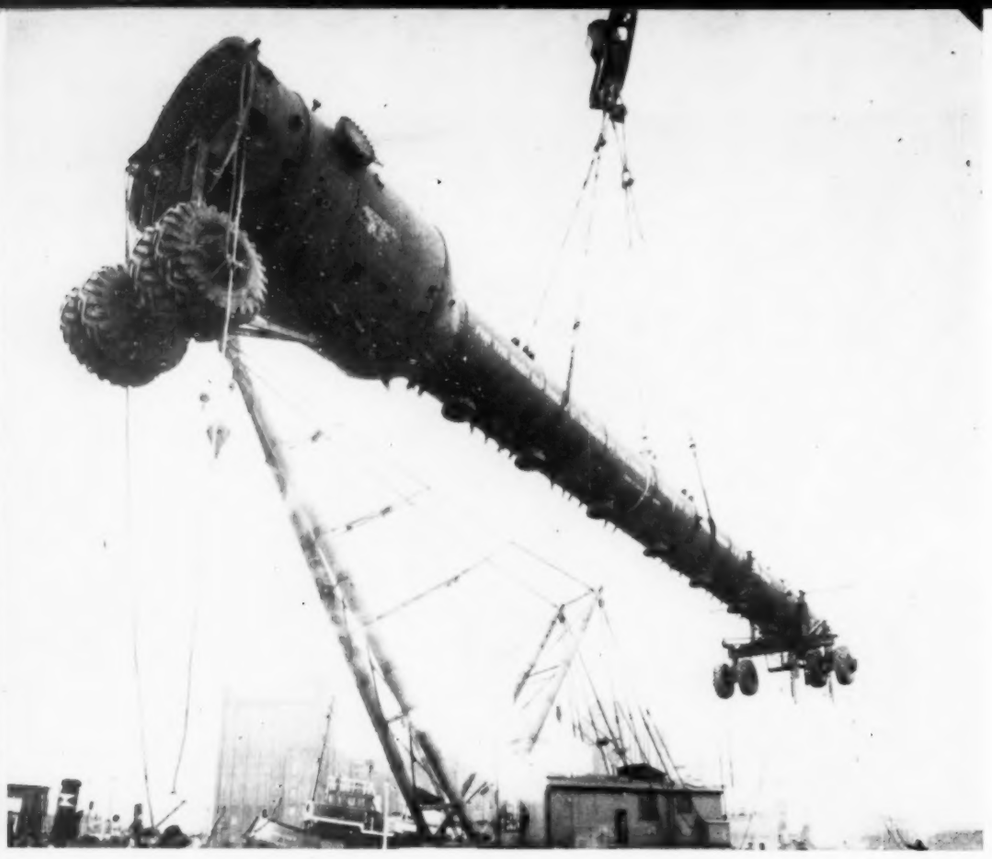

Pressure vessel fitted with undercarriages and tires prior to launching at Birkenhead for towing to Ireland. The vessels were towed ashore on arrival. Photo courtesy R. W. A. Clark.

Ireland's first refinery follows "hydro-skimming" plan

Unusual transport problems were encountered in combined land and sea movement of heavy vessels for which special transport gear was designed.

The possibility of building a petroleum refinery in the Republic of Ireland is one which has been examined from time to time by various interests, but the size of the market has hitherto militated against the development of petroleum manufacturing in that country. However, for many years, the government policy in the republic has been aimed at the encouragement of industry by every possible means so that the country may be self-sufficient as far as practicable. In line with this policy, the major petroleum organizations operating in Ireland were approached by the Irish Government with the request that they should consider a joint manufacturing operation. It was realized that no single company could justify the building of a refinery to supply its own marketing needs, but that if a single refinery were built to meet the requirements of all the marketers, then it should be possible to operate such a unit economically. The three organizations concerned in this project were Caltex, Esso and Shell-Mex and B.P. Negotiations with the Irish Government were brought to a successful conclusion in the summer of 1956 when the three participants agreed to accept the government's proposal that they should jointly build a refinery to meet their domestic needs of major products.

Considerable thought was given to the possible location for the refinery. The main factor influencing this decision was the necessity to accommodate the large size tankers being used in the crude oil trade. It was finally decided to build the refinery near Cork Harbor where there are deep water facilities for these large tankers. Other locations were considered on the west coast, but in general they were too remote from major consuming areas. Following on this decision, land was purchased in the vicinity of Whitegate Village, which is located just to the east of the entrance to

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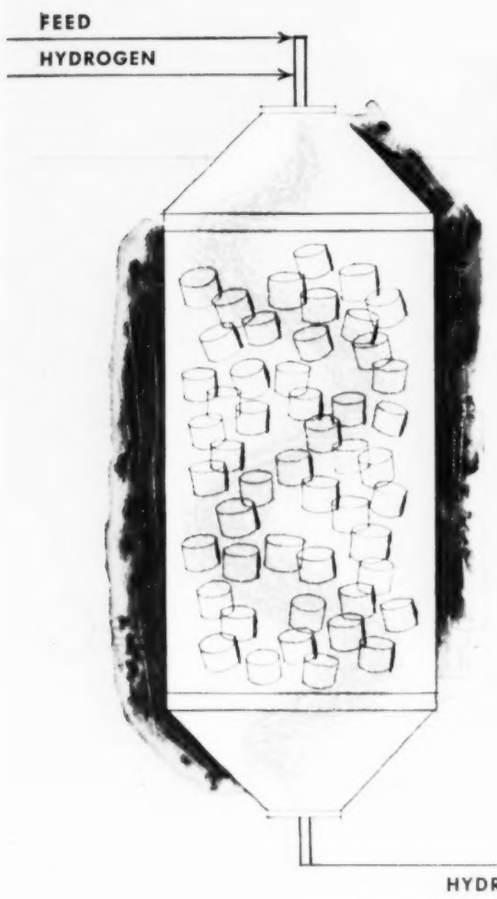

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Rear of control room panels. Photo by Elwood Payne for The Lummus Co.

Gallery on which are mounted the air fin coolers showing motors which drive fans for the coolers. Photo courtesy The Lummus Co.

Cork Harbor. Sufficient land was purchased to cover the needs of any expansion that might take place in the future. The site chosen for the refinery area is at an approximate elevation of 140' above sea level, overlooking the Cork harbor. The site was an excellent one from a building foundation point of view—rock being present a short depth below the surface, although, fortunately, no great amount of rock excavation was found necessary during the course of construction.

Preliminary studies were initiated in 1955 so that a decision could be taken regarding the type of refinery to be built. Due to the smallness of the market, a minimum investment refinery was indicated, designed to cover the major petroleum requirements and, taking into consideration the balance between the various products required, it was evident that a hydro-skimming plant would be best suited to the needs of the Irish market. In other words, the desirable type of refinery would consist of crude topping facilities, together with catalytic reforming equipment for the upgrading of virgin naphtha for octane number improvement. The recent upward trend in fuel oil sales, as compared with gasoline sales, had reduced the need for catalytic cracking facilities, and, accordingly, this latter operation was not considered necessary as a part of this development for the manufacture of high grade gasoline. Accordingly, the products to be manufactured were: two grades of gasoline, tractor fuel oil, turbo jet fuel, auto diesel oil, gas oil, light fuel oil, medium fuel oil and heavy fuel oil.

The basic process engineering design of the refinery was put in hand with the Esso Research & Engineering Co. in the summer of 1956 and the contract for the engineering and construction of the refinery was placed with The Lummus Co. Ltd. in 1957. Contracts were also awarded at this time to George Wimpey & Co. Ltd. for the marine terminal, Tank Erectors Ltd. for the tankage, and P. J. Hegarty Ltd. for the refinery buildings. Grading of the site commenced in August 1957. In general, progress of construction has been satisfactory and start-up operations are now under way. In line with assurances given to the Irish Government, every effort has been made to use to the maximum Irish personnel and Irish materials, and, of the total cost of approximately £12,000,000 for the refinery, approximately £3,000,000 has been spent in Ireland. Before the commencement of construction, The Lummus Co. negotiated an agreement with a group of local Irish unions covering conditions of employment, and, in general, relations with these unions have been very satisfactory during the course of construction and the job has been free from any disputes of a major nature. Inclement weather throughout 1958 made construction activities particularly difficult, but in spite of this, the completion time has been very close to the dates originally forecast in planning.

Refinery design is based on a crude distillation capacity of 39,600 b cd of Middle East crude and the refinery processing units consist of an atmospheric crude topping unit, a catalytic reforming unit for octane upgrading of virgin naphtha, a copper sweetening unit, and a middle distillate catalytic desulfurization unit.

Crude is discharged from the tankers into the crude storage tanks on Corkbeg Island approximately half a mile from the main refinery site. This location has the advantage of being only 40 feet above sea level whereas the refinery itself is 140 feet above sea level, and, accordingly, the discharge of the crude tankers is more rapid than it would have been if the crude tanks had been located close to the process units.

From Corkbeg the crude is pumped to the crude distillation unit surge drum. From here it is pumped through the furnace to the main distillation column and the coil outlet temperature on the furnace is controlled to give a bottoms product of heavy fuel oil quality. Lighter grades of fuel are made by blending back with gas oil at the unit. A light naphtha cut is taken out off overhead and is then debutanized and split into two fractions, the lighter of which goes to the copper sweetener for gasoline blending and the heavier to the catalytic reformer for octane improvement. Two side streams are withdrawn from the main distillation column, first a heavy naphtha cut which is used partly as catalytic reforming feed and partly as blend stock after sweetening for tractor vaporizing oil and turbo-jet fuel, and secondly a gas oil cut, some of which goes to the catalytic desulfurization unit. In the desulfurization unit further blend stocks are prepared which are used for diesel oil, tractor vaporizing oil and turbo-jet fuel manufacture.

In the catalytic reforming operation the raw virgin naphtha is first desulfurized and is then passed through a series of reactors containing platinum catalyst which results in hydrocarbon conversion giving high octane blend stock for blending to give a premium and regular gasoline. This unit also provides a high octane component for blending into tractor vaporizing oil, as well

Furnace and Powerformer, left foreground. Vaporizing heater and crude fractionation unit, right background. The Lummus Co. photo.

as propane and butane for the LPG market.

One of the most notable features in the design of the Whitegate Refinery has been the use of air-fin coolers for the cooling of the product streams. The use of water for this purpose has been entirely eliminated. Apart from the savings in capital investment, this new system has the great advantage of reducing very considerably the pollution hazards associated with the handling of large volumes of cooling water subject to contamination with oil. Surface drainage from the refinery passes through a skimming pond before discharge to the harbor.

All the process units are controlled from one control room which has been centrally located, with the units grouped around the building.

The steam plant consists of three package-type boilers with ion-exchange water treatment facilities.

Any waste gases released from the process units are burnt in a low elevation smokeless flare of multi-jet burner design.

In the design of the refinery maximum use has been made of reinforced concrete construction rather than structural steel. All the air-fin cooler structures have been built this way, and also the pipe supports around the refinery. By so doing maximum use has been made of indigenous materials.

The marine terminal also is of reinforced concrete construction and has been built out from Corkbeg Island to the navigable channel in the harbor, a distance of 2,400 feet. The jetty has an L-shaped pier head with two berths, the outer one for crude tankers and large coastal product vessels, and the inner one for the smaller coastal vessels. A certain amount of dredging is being carried out at the face of the jetty head, so that the larger crude vessels may be accommodated.

At the time of writing (end-May) construction activities are practically finished and startup operations are under way. Initial deliveries of Middle East crude were made to the refinery during the month of April, and very soon products will be delivered to the Irish market.

Transport Problems Associated with Whitegate

With a location 30 miles southeast of Cork and 170 miles southwest of Dublin, the limitations imposed by bridge capacities, road widths, port facilities and carrier deck space, all combined to create special transport problems for the larger pieces of refinery equipment for the main contractors. Lummus found it desirable to conduct an extensive transport survey to assure economic handling of all major refinery equipment. As a result it was found all equipment could be handled in conventional manner with the exception of five pressure vessels which, because of size and/or weight, required special consideration. For these five vessels the problem involved:

(a) Selection of an embarkation port centrally located to fabricator's shop and offering adequate crane facilities.

(b) Development of refinery site natural features to facilitate landing and handling of the pressure vessels without shifting or duplicating heavy lifting gear.

(c) Design of transport gear conforming to maritime regulations with sufficient flexibility to serve beaching operations and as a means of transport for the vessels from beach to site foundations.

(d) Coordination of the various groups concerned with launching, towing, and landing of the pressure vessels.

Liverpool was selected as a point of embarkation and with the able assistance of the Mersey Docks and Harbor Board and Hogg Robinson & Capel Cure, facilities were made available for receiving pressure vessels, attaching the undercarriage and launching.

Front and rear undercarriages were designed with bracket and brace attachments to accommodate five pressure vessels of the following sizes and weights:

Vessel	*Diameter*	*Length*	*Weight (Long tons)*
1	12'-0"	48'-0"	26
2	6'-6"	89'-0"	25
3	8'-6", 13'-0", 5'-6"	119'-0"	50
4	6'-6", 10'-6"	107'-0"	77
5	6'-0", 10'-0"	106'-0"	67

Three point suspension was incorporated in the undercarriage design, the front being provided with two swivel axles and vertical pins, with a single swivel axle and vertical pin in the rear. The undercarriages were mounted on eight Dunlop 18 x 25, 20 ply rubber tires. For the front undercarriage compensated link steering, actuated by crosshead drive from an internal combustion engine through reduction gear was provided. A steering bar was provided for the rear undercarriage.

To minimize rehandling when attaching undercarriage and when erecting the vessels at the site, pressure vessels were orientated on lorries at the fabricator's shop with respect to the position required on the foundations. Vessels were pressurized with air at the fabricator's shop and rechecked upon arrival at Birkenhead. Preparation for launching consisted of attaching both undercarriages, mounting marine running lights and air pressure warning signal lamp and installing a repressurizing hookup to the tug compressor. Attachment to the tug

"One of the pillars of our nation's strength is a multiplicity of small, medium, and large-sized companies. All make particular contributions to the economy and each is dependent for its health upon the general health of the others."

— Eugene Holman, Chairman of the Board

Standard Oil Company (New Jersey)

and affiliated companies

was made by 1 5/16" link bridle to which was attached 35 fathoms of 4-in. tow wire and 110 fathoms of 14-in. manila howser.

Towing from Birkenhead to offshore of the site was handled by Steel & Bennie Ltd. All tows were successfully carried out at speeds of 4 to 6 knots depending on weather conditions and time required to effect the Liverpool-Whitegate crossing varied between 43 and 120 hours, the latter being due to sheltering for 53 hours because of severe weather conditions. Drafts for the various vessels ranged between 11 ft-1 in. and 13 ft 3-in. and even during severe weather conditions the pressure vessels under tow were observed to be stable and maintained course without sheering.

On arrival offshore transfer was made to a Cork Harbor Commission tug and beaching was carried on under the supervision of a shore based beach-master. Instructions to both the shore winch operator and tug master were issued by radio-telephone. The purpose of the offshore tug was to maintain vessel on course with the landing track during beaching.

Hauling from beach to site and erection on foundations required from two to six hours depending on the vessel weight and location of the vessel in the refinery area.

MAJOR EQUIPMENT SUPPLIERS WHITEGATE REFINERY PROJECT

Main Contractor
The Lummus Co., Ltd.

Main Equipment Suppliers

Pumps, compressors & drives: Hayward Tyler Ltd., Pulsometer Eng. Co. Ltd., Sigmund Pumps Ltd., E.C.D. Ltd., Ingersoll Rand Co., Alley & McLellan Ltd., Metropolitan Vickers.

Pressure vessels & internals: Babcock & Wilcox, Ashmore Benson & Pease, Millspaugh Ltd., Davey Paxman, G. A. Harvey & Co., Ltd., R. K. Saxton Ltd., Daniel Adamson, Metal Propellers Ltd., A. Johnson & Co. Ltd.

Heat exchangers: Hudson Engineering Group, Head Wrightson Processes Ltd., A. F. Craig & Co., Ltd., Ashmore Benson & Pease, Whessoe Ltd., Babcock & Wilcox Ltd., Daniel Adamson & Co., Ltd., Brown Fintube Ltd.

Electrical equipment: London Transformer Products, Advance Components Ltd., Crompton Parkinson Ltd., Metropolitan Vickers, Igranic Ltd., Metropolitan Vickers, Unidare Ltd. (Simplex material). M & C Switchgear Ltd., Electrical Apparatus Co., G.E.C. Ltd., T. N. Hughes & Son (Verity material).

Furnaces & boiler plant: S. W. Farmer & Son Ltd., Smith & Pearson Ltd., Universal Fabricators, Thomas Heiton Ltd., Guest Keen & Nettlefold, Gibbons Huertey Ltd., T. I. Export Ltd., Liptak Ltd., John Thompson Water Tube Boiler Ltd., Samuel Osborn & Co. Ltd., Newalls Insulation Co. Ltd., R. B. Hilton & Co. Ltd., National Airoil Co. Ltd.

Instrumentation: Honeywell Brown, Electroflo Meters, Taylor Controls, Elliott Bros., Fisher Governor Co., Richard Klinger Ltd., Ronald Trist Ltd., Negretti & Zambra, Sydney Smith & Co., Dwrance & Co., Exeter Munitions, Bailey Meters Ltd., Alexander Controls, British Rototherm, Letchworth Sheet Metals, Spirax Sarco Ltd., Triangle Valve Co., Hartons Installations Co., Sheet Metal Eng. Co. Ltd.

Piping & accessories: Stewarts & Lloyds, T. I. Export, A. E. & N. Ashton, L. B. Foster & Co., Franklin Supply Co., Capitol Steel & Pipe Co. Ltd., South Durham Iron & Steel, Babcock & Wilcox, Stanton Iron Works, Staveley Iron & Chemical Co., Clay Cross Ltd., Tonge & Taggart, Yorkshire Imperial Metals Ltd., John Wilkes Son & Mapplebeck, Triangle Valve Co. Ltd., Newman Hender & Co. Ltd., Chapman Valve Co., H. W. Dennis & Co., Guest & Chrimes, Sella, Audley Engineering, Crane Ltd., Sydney Smith & Sons, G. M. Marchant Ltd., Joseph Strack, S. McCormack & Sons Ltd., Irish Stone & Fire Clays Ltd., John Sisk & Co., Sharp Jones & Co. Ltd., Wolstenholmes Ltd.

Civil work: John Paul & Sons Ltd.

Diesel Engines: Henry Meadows Ltd.

Inert Gas Generator Drier: W. C. Holmers Ltd., Birlec Ltd.

Water Treating Plant: John Thompson-Kennicot Ltd.

Complete Telephone System: Standard Telephone & Cables.

Fire Extinguishers: Fire Armour Ltd.

Air Conditioning Equipment: Keith Blackman Ltd.

Mechanical Mixers: L. A. Mitchell Ltd.

Mechanical Service Building: Thos. Thompson & Son Ltd.

Heating Equipment: F. H. Biddle & Co. Ltd.

Structural: Sheet Metal Eng. Co., Kennan & Sons, G. Milner & Sons Ltd., J. & C. McLoughlin Ltd., Thos. Thompson Ltd., Smith & Pearson, Smith Walker & Co.

Insulation: M. A. Boylan & Co. Ltd., Cape Asbestos Co. Ltd.

Tankage: Tank Erectors Ltd.

Marine Terminal Structure: Geo. Wimpey & Co. Ltd.

Mechanical Maintenance and Machine Tool Equipment: Welding Supplies Ltd., Kodak Ltd., Chas. Warren Ltd., Globe Pneumatic Eng. Co., Blackwood Hodge (Eire) Ltd., Ruston Bucyrus Ltd., S. McCormick Ltd., Strangfords Ltd., J. H. Eames & Sons, J. H. Saville Ltd., Dixon & Hempenstall, Fleming & Co. (Dublin) Ltd., Schmidt Tyschen-Hamburg, Broom & Wade, Consolidated Pneumatic Tools.

Crude unit is at left, Pumphouse with compressors and deaerating feed water heater for boiler plant, right foreground. Photo courtesy The Lummus Co.

H&W - COOPER-BESSEMER Compressors

.... FOR OIL REFINERY SERVICE

Four 8-cylinder, gas-engine-driven, H & W-Cooper-Bessemer GMV type Compressor Units with non-lubricated cylinders, recently installed by Texaco Trinidad, Inc.
Each engine develops 880 b.h.p. at 300 r.p.m. Compressor Cylinders are of forged steel suitable for a pressure of 3,000 lbs. p.s.i.

Other H & W-Cooper-Bessemer horizontal and centrifugal Compressors are available in many sizes and with a great variety of compressor cylinders offering a wide range of volumes and pressures for handling air or any kind of gas.
Compressors can be supplied for heavy-duty motor, turbine, or engine-driven service with pressures up to 25,000 lbs. p.s.i.

HARLAND & WOLFF
LIMITED

Engineering Works: Queen's Island, Belfast.

London Office: 9, Whitehall, S.W.1

LZ80

New automation tools for oil processing

Process Master Analog Computer

An advanced type Process Master Analog Computer featuring specialized capabilities for handling design and operating problems encountered in the oil industry was unveiled at the World Petroleum Congress by Computer Systems, Inc., New York. Reportedly one of the largest and most modern analog computers to be built to date, an MC-5900 will be put into operation at Humble Oil & Refining Co.'s Texas refinery around August, 1959.

The Humble Oil installation will be used as a process master computer in research and development work on new processes, optimization of existing refinery operating units, and to speed and improve processes and mechanical design in all phases of the company's operations.

Developed specifically for petroleum, chemical, and other processing industry applications, the new master computer incorporates a number of unique features not heretofore available in general-purpose analog computers. Precision repetitive operation at 50 solutions per second permits processing engineers to vary equation coefficients and observe resultant effects continuously on a 17-inch oscilloscope. The MC-5900 computer also incorporates dynamic memory, generation of function of two variables, dynamic function generation, and high frequency performance not previously available.

The MC-5900 differs radically in concept from older computers in two other respects: expandability and packaging. Equipped with 202 operational amplifiers, 60 electronic multipliers and 20 ten-segment diode function generators as basic computing elements, the facility is readily expandable to more than twice this size.

The basic computer employs expanded unique circuit logic, so that a purchased computer may be expanded in the field on a "building block" basis without rewiring or mechanical modification. Expansion may be accomplished with respect to function as well as size. In addition, a new packaging technique allows the computer to be instantly "unzippered" from cabinet confines to provide unobstructed access during maintenance.

Refining offers a broad range of applications for the MC-5900. The computer solves for complete distillation and conversion parameters in such processes as catalytic cracking, dehydrogenation, hydroforming, hydrofining, adsorption, fluidization, and the like. Quality control and process control by general purpose computers are now made practicable.

The computer provides design data for maximum efficiency throughout refining operations. For the first time, kinetics for highly complex parallel reaction systems can be solved and defined automatically. The MC-5900 can be used for analyses of operations and for automatic control of processes, data being provided for the development of complete process models as well as cracking, dehydrogenation, and other mechanisms. Indeterminate and continuous structures can be completely analyzed and solutions presented in final isometric form.

The new MC-5900 computer also provides an advanced mathematical tool to aid the science of operations research. Simplicity of operation and speed are provided for handling matrix algebra, linear programming (with non-linear elements), economic evaluation, optimization, and automation.

Additional exclusive features incorporated in the MC-5900 Process Master Analog Computer include an Automatic Digital Recording and Control system (ADRAC) with fully transistorized data selection circuits. No stepping or crossbar switches are required. The computer also has ultra high gain operational amplifiers, wide-band electronic multipliers, and extremely stable function generators.

Other field additions which can be made to the basic computer embrace repetitive operations mode, time scale change, dynamic and/or static problem check, diode function generator devices, and digital input and/or output systems with punched tape, punched card, or keyboard control.

Portable Process Recorder

Southwestern Industrial Electronics Co., a division of Dresser Industries, Inc., has introduced a trailer-mounted portable process dynamics recorder which gathers data from an operating process, and records this information in digital form on tape for computer analysis. The PDR-1 accepts the output of transducers measuring temperatures, pressures, flows, levels, stresses, etc., directly and linearizes scale factors and filters data prior to recording on magnetic tape. The PDR 1 can sample 5 separate channels of information at sample speeds up to 40 samples per second per channel. It can also accept 60 individual signals and record them at rates up to $2\frac{1}{2}$ seconds per scan. Overall recording accuracy of signals with a 0.001 cps to 10 cps frequency range is 1%. The tape output is compatible with commercial computers such as the IBM 650, enabling complete process recording, from which operating trends are readily discernible. It can also be used as a portable data logger or control room with typewriter readout.

Liquid moisture monitor

Moisture Monitors

During the past year Consolidated Electrodynamics Corp. introduced two new instruments that continuously, automatically and accurately measure the presence of trace quantities of water in gases, vapors, or even liquids. They are designed for verifying dryness of chemical and petrochemical process streams, natural gas in pipelines or high-pressure wells, hydrogen feed in ammonia plants, and driers.

There are two moisture monitors in the series, both of which cover a dynamic range from 1 to 1,000 ppm. One has a maximum sample pressure of 6,000 psig and the other operates at up to 10,000 psig.

A self-contained battery pack permits portable use of the 34-pound instrument, and it can be operated on 105 to 125 volts, 50 60 cycle a-c when line power is available.

More recently, CEC introduced a moisture monitor for liquids. An important application will be the detection of moisture in jet fuel. Existing photoconductivity tests fail to detect dissolved water, and even a few parts per million can freeze at low temperatures. Another typical application is the detection of moisture in catalytic reformer feed.

Viscomparator

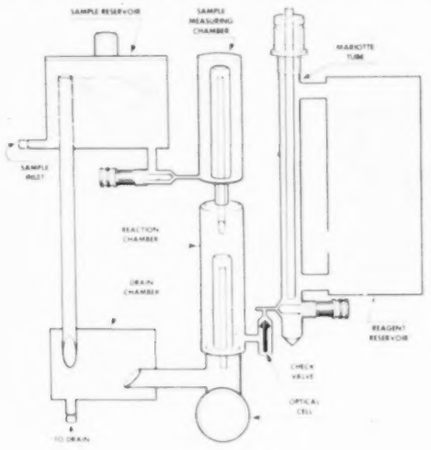
Bendix Aviation Corp. has developed the Viscomparator for continuous measurement and control of product viscosity. Applications are in fuel oil and asphalt blending, asphalt oxidation, vacuum tower operation and motor oil can filling.

The Bendix Viscomparator measures and controls the viscosity directly and continuously by comparing the process fluid with a standard sample of the blended product which is inserted in a well in the process line. Since control action is based on standard sample viscosity, the blended product is caused to have the proper viscosity, independent of process temperature. Multi-product systems allow the operator to select a desired product sample from as many as 13 product samples by means of a simple selector switch.

The Viscomparator utilizes viscosity sensing probes made of stainless steel which give satisfactory performance at pressures from vacuum to 1,000 psi and at temperatures to 650°F. The sensing probe is supplied with explosion proof junction box and is acceptable for operation in hazardous areas. Probes can be located as far as 1,000 ft from the instrument.

A small metal reed is vibrated at ultrasonic frequency to shear the material under examination. Viscosity is measured as a function of the energy damping of the reed element.

The Bendix Viscomparator features wide range temperature compensation with the process material compared directly with a sample of the desired product at process temperature. The elertronic section of the system is essentially self-compensating, since both probes operate into the same set of electronic components. The Bendix Viscomparator was designed to provide accurate viscosity monitoring and control with a minimum of time required to change from one product to another.



Chemalyzer

Automatic Colorimetric Analysis

Developed in Belgium and brought to this country by Robert T. Sheen, president of Milton Roy Co., the new Chemalyzer instrument introduces low-cost, automatic colorimetric analysis to the chemical and petroleum industries for the first time. Costing only one-third as much as the lowest-priced conventional analyzer, the unit embodies a unique design principle, has no moving parts and is powered entirely by the gravity head of the sample. It enables untrained operators to make tests with unerring accuracy in a fraction of the time formerly required.

Automatic Heavy Oil Blending

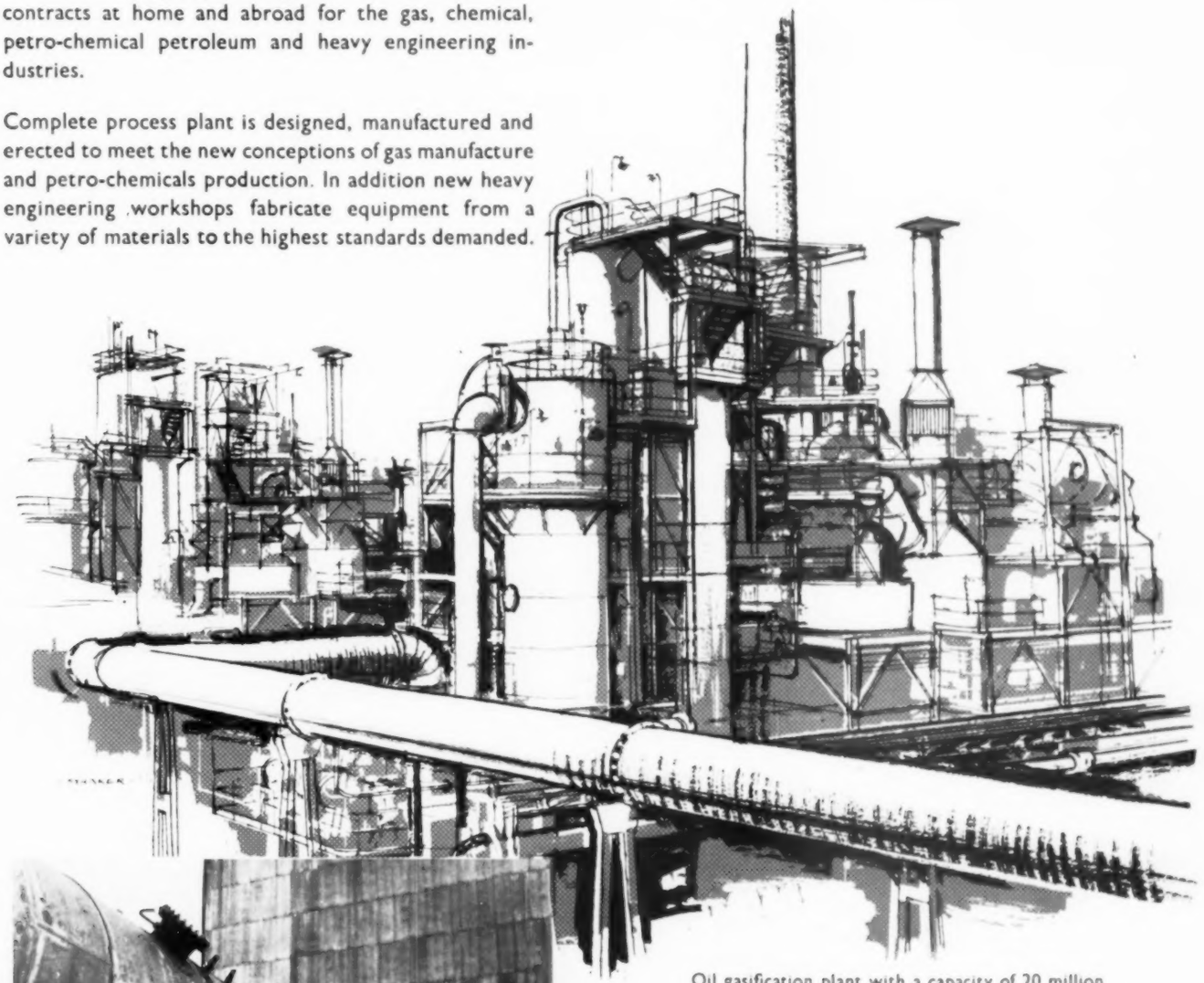
Automatic in-line blending of refinery stocks has been extended to fuel oils and asphalts by Proportioneers Division of B-I-F Industries Inc. The blender enables direct blending of asphalt and solvent into tank trucks, tank cars, or storage, eliminating excessive tank storage facilities, mechanical mixing, foaming, evaporation of solvent and human errors. This in-line method of blending minimizes fire hazard. In addition, the resultant blend is more uniform and can be duplicated for any number of batches and quantities.

The entire operation is fail-safe with the blender automatically shutting down if proportions are not maintained, or supply fails. The blend of solvent and asphalt is adjustable from 5 to 50% solvent

Project and Equipment Engineering

The Power-Gas group of companies have fulfilled major contracts at home and abroad for the gas, chemical, petro-chemical petroleum and heavy engineering industries.

Complete process plant is designed, manufactured and erected to meet the new conceptions of gas manufacture and petro-chemicals production. In addition new heavy engineering workshops fabricate equipment from a variety of materials to the highest standards demanded.



Oil gasification plant with a capacity of 20 million cu. ft. per day of town gas.

Pressure vessel 119' 3" long x 13' 0" dia. weighing 50 tons leaving South Works. Manufacture included chrome and Monel clad mild steel.

THE POWER-GAS CORPORATION LIMITED

Associate Companies

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ROSE, DOWNS & THOMPSON LIMITED

LONDON · STOCKTON-ON-TEES · HULL

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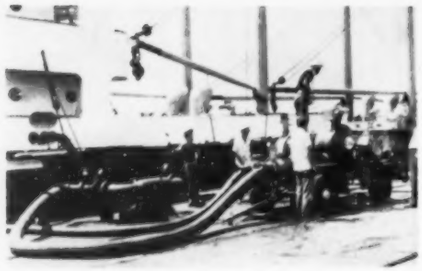


Mobile Blender in use at dockside, Esso's Cristobal Bunkering Station where Bunker C and distillate fuels are custom blended.

with the resultant blend accurate to ½% of the setting. The blend rate can be controlled at the loading arm by the operator filling the tank truck or tank car.

Proportioneers also has developed fuel oil blenders both for refinery installation and for point-of-sale blending to customer requirements. A mobile bunkering blender for dockside use needs no outside power supply, but is operated by a pressure differential between the residual and distillate fuels being blended.

Either portable or mounted on skids for permanent or semi-permanent installations, the Proportioneers Fuel Blender provides continuous and automatic on-the-spot stream blending directly to the ship from base stock storage tanks. There is no need to store a great inventory of fuels of different viscosities—hundreds of finished blends—in countless storage tanks. Short notices of two or three hours need not cause concern.

With the Mobile Blender the proper viscosity fuel can be blended on the spot, and from a few storage tanks. In addition, extra pumping and facilities are eliminated and multiple base storage tanks and special blending tanks are not required.

The mobile bunkering blender has provision for automatic shut-off in event of failure of one of the streams. It follows varying flow conditions, regulating itself without upsetting the present percentage of residual and distillate. Adjustment is from 90% residual and 10% distillate to 50% residual and 50% distillate fuel.

The blender contains two positive displacement meters, one for measuring residual and the other for distillate fuels. These are linked together through an adjustable variator and mechanical differential which operates the blender and stops all pumping action should either line stop. Because each stream contains its own totalizer, inventory checks can be made on the spot at any time.

Maximum operating pressure of the mobile bunkering blender is 300 psig, 30 kilograms per square centimeter. Standard design allows for capacities of 2,100 gpm U.S., or 1,710 gpm Imperial—480 cubic meters per hour. Higher capacities are available on request.

The blender itself is 110 inches long, not including a 50-inch pulling bar. It stands approximately 77-inches high, including platform and wheels. Distance from ground to center of line piping is approximately 35-inches. Shipping weight is 7,000 lbs.

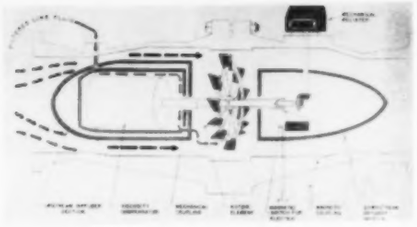
Digital Control Computer

General Electric Co. has announced a digital control computer, C-312A, which may be employed in on-line operation coupled to the process of off-line as a separate computer. The transistorized computer which uses also diodes and other solid state devices has a built in air conditioner for greater component reliability. Cabinets have filtered air intakes and gasketed doors.

Of modular construction the printed circuit boards are immediately accessible and removable. Test points for in-operation checks are below the handle of each board. Boards are of the plug-in type and sockets are coded to eliminate incorrect reinsertions.

The computer has a repertoire of more than 60 commands. Single word or 1 + 1 may be intermixed for ease in programming and an increase in storage.

The computer uses punched paper tape input and electric typewriter output. Additional digital outputs are available. The magnetic memory drum has a capacity of 2,048 to 16,384 words. Average access time is 6.25 milliseconds. Drum speed is 4,800 rpm.



Rockwell 16" Turbo-Meter

Multi-Purpose 'Turbo-Meter'

Rockwell Manufacturing Co. exhibited a new 16-inch, 15,000 bph capacity positive "screw displacement" meter at the International Petroleum Exposition at Tulsa. Designated as the Rockwell "Turbo-Meter", the instrument is claimed to have an accuracy of better than 15 parts in 10,000 and repeatability of better than one part in five thousand.

Design features include a rotor metering element weighing only 4 pounds; a newly developed viscosity compensator; and a magnetic coupling completely sealed from the line product. The Turbo-Meter is based on the principle that there is a direct relationship between the rate of liquid flow through the meter and the speed at which a rotor element is rotated by the force of the flowing liquid.

Computerized Control System

Libroscope Inc., a subsidiary of General Precision Equipment Corp., has developed a computerized control system for petroleum and chemical industries. In operation, the Libratrol-500 receives incoming data from monitoring devices, processes the data through a general purpose computer and provides accurate control information either for a human operator, or for automatic control elements within the processing equipment. Basic to the system is a highspeed digital computer which was designed to cope with three factors: a large number of variables, the requirement for intermittent information storage, and the rapid computation common to the majority of process problems.

Inputs to the computer are derived from standard process instrumentation and may be in the form of voltages from analog instruments, digitized transducer signals, and fixed data and similar information from the process operating personnel. Operating in the binary numerical system, the computer requires information in digitized binary form. Suitable conversion units for the various data sources perform the translation.

Input rate of the computer is 200 data words of 31 bit length per second. Inputs to the system are scanned and conditioned on command from the internal stored program regulating the computer functions. The program directing the computation and control system operations is stored in the computer and can be modified to incorporate desired operating functions.

Capabilities of the arithmetic unit include add and subtract times of 0.25 milliseconds, multiplication or division times of 15 milliseconds minimum.

The magnetic drum storage unit has a capacity of 4,096 words.

Outputs from the computer may be in the form of voltages to actuate control elements, digital data for presentation to operating personnel, or punched tape for further data processing operations.

Power requirements for the computer only are 115 volt, 60 cycle single phase, at 17 amperes. Input commutators, signal conditioners, conversion, actuating, and other complementary equipment for specific applications require additional power.

In its basic mode of operation, the Libratrol-500 monitors the on-stream process, compiles the various data, performs the required computations, and presents the information to the process operator. All subsequent evaluations and decisions are the responsibility of the operator. Specific information for accounting and management is tabulated.

The Libratrol-500 may be used to calculate, on the basis of data monitored by instrumentation and information and logic stored in the computer, what the optimum control settings in the process should be. The information presented to the operator permits him to alter the process controls in keeping with the optimizing criteria and additional factors which the computer may not take into account.

In those processes where the relationships between the primary variables and the secondary process characteristics are firm enough to establish automatic operating criteria, the computer is used in its third mode of operation—automatic control of the process. Regulation is accomplished by conventional feedback controllers with the computer carrying out the automatic trimming operations by monitoring set-points and changing them as calculations indicate the necessity.

SIE Analog Computer

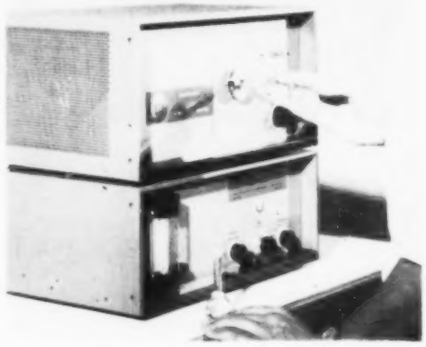
Analog Computer

Southwestern Industrial Electronics Co. a division of Dresser Industries, Inc., has introduced its CM-2, a completely solid-state computer for all-purpose mathematical computations. It consists of operational amplifiers, logarithmic networks and scaling potentiometers. Use of transistors and magnetic amplifiers provides the reliability and ruggedness needed for industrial applications. An integral programming board inside the cabinet facilitates programming of functions. The CM-2 meets Class 2, Section 1 conditions with an air purge. It has wide applications for computation and control of variables in chemical, petrochemical, refining and industries.

The CM-2 is housed in a steel cabinet with door, finished in corrosion-resistant vitreous grey enamel. All units are hermetically sealed, mounted on swingout frames for quick accessibility and replacement. Each CM-2 cabinet can house up to 12 operational amplifiers, 6 logarithmic networks and 8 scaling potentiometers. Any number of units up to maximum capacity can be specified when ordering, or several CM-2's can be used in banks with their programming boards interconnected, as functional requirements demand.

High Temperature Chromatograph

Consolidated Electrodynamics Corp. added a new high-temperature chromatograph to this line of laboratory and processing instruments. The chromatograph operates at a maximum temperature of 500°C, allowing it to separate and analyze substances with boiling points up to 600°C. It can perform quantitative analyses by the elution method of complex



High-temperature laboratory chromatograph

IN CANADA: G. DIKKERS OF CANADA LIMITED, SCARBOROUGH, ONTARIO

mixtures such as fatty acids, biphenyls, terphenyls, glycols, phthalate esters, nitriles, and diglycerides. It also may be used for all standard chromatographic analyses above 50°C.

Tubeless Electronic Control

A series of solid state electronic control instruments has been introduced by The Foxboro Co. The transmitters, recorders, controllers, and valve operators, cover every function in the process control loop. Typical process measurements such as pressure, flow, and level, are converted at the transmitters to proportional current signals and instantaneously transmitted over unshielded lines to a control center. Converters for EMF and resistance measurements also feed signals to the small case, panel-mounted receivers. In the same electrical range are the controllers and final operators which complete the loop.

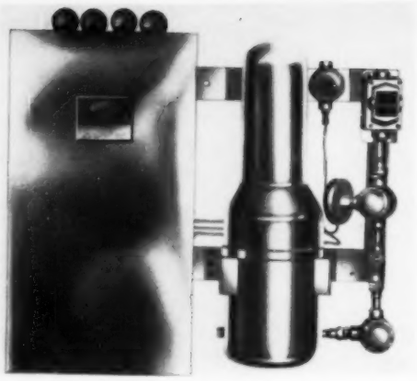
Outstanding features of the instrumentation, in addition to the use of magnetic amplifiers and transistors, are: choice of motion balance or force balance transmitters; electrical measurement converters; availability of such devices as alarms, flow totalizers and computing devices; a completely new approach to control station design; and diversified installation arrangements using standard system components.

Other features of the instrumentation include: d-c transmission so that unshielded leads can be used throughout with no effect from a-c pickup; a current system unaffected by changes in line or load resistance induced by ambient temperature.

Also: pull-out construction so that key subassemblies can be inspected or replaced with minimum disruption of system operation; and optional explosionproofing to comply with the requirements of Class I, Group D, Division 1, and Division 2 locations.

End Point Analyzer

Technical Oil Tool Co. demonstrated a new end point analyzer at the Tulsa oil show which provides continuous analysis when end point is important to quality or yield. Signals may be fed directly to controllers or recording charts. Within the range of 200-600°F. reproducability is within ±1°F.

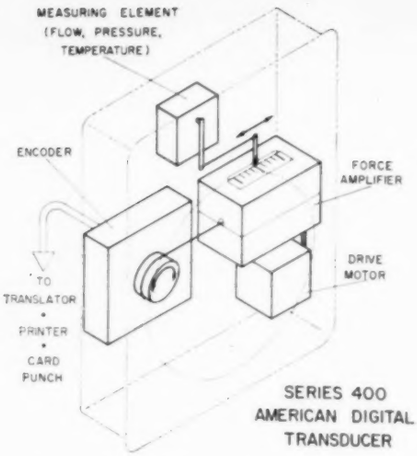


Endpoint Analyzer

The new analyzer consists of four main components: a boiling pot with constant heat input; a fractionating tower packed with Berl saddles; a pneumatic pressure control system; and a temperature sensing unit. The weatherproof, explosionproof TOTCO analyzer meets all requirements for Class I, Group D applications.

Digital Transducer

American Meter Co. has announced a digital transducer for encoding flow, pressure, temperature and liquid lever. Employing the American force amplifier need is eliminated for electronic servos, vacuum tubes, magnetic amplifiers or electronic components. The amplifier is completely mechanical and is powered by a small electric motor. The primary measuring element may be a mercury or bellows type manometer for flow or liquid level, a Bourdon tube for pressure, or a filled thermal system for temperature. The measuring element is connected to an American force amplifier which positions the shaft of an analog to digital converter. The encoder output may be connected to a translator for visual readout or other customer furnished equipment for print-out, data handling, or control.



SERIES 400
AMERICAN DIGITAL
TRANSDUCER

Force-Balance System

A two-wire d-c system employing transistors for electric process control has been developed by the Minneapolis-Honeywell Regulator Co. The wires carry the measurement or control signal as well as the system's power. Only power connection is made at the receiver—none at field-mounted devices.

The system consists of a transmitter, receiver, controller and final control element. The transmitter measures any process variable, translates it into a standard 4 to 20 milliampere direct current signal, and transmits to the receiver through a pair of cop-

(Continued on page 124)

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SALTS and impurities in the crude charge	**PETRECO*** Electric Desalting **TRET-O-LITE*** Chemical Desalting	These Petrolite desalting processes, and TRET-O-LITE desalting chemicals are recognized throughout the refining industry as the best available.
CORROSION	**KONTOL*** Corrosion Inhibitor	is an organic semi-polar liquid, available in a variety of formulas. It adsorbs on interior metal surfaces to prevent corrosion caused by chlorides, sulfides, organic acids, other corrosive agents, and hydrogen blistering. KONTOL Corrosion Inhibitors also possess effective detergent qualities which help prevent plugging and fouling in heat exchange equipment.
PRODUCT DEGRADATION from organic acids, arsenic nitrogen bases, gums, lead, sulfur	**ELECTROFINING*** Electric Precipitators	provide an economical method for treating distillates with acid, caustic, doctor and many other treating chemicals—to improve brightness, color stability, facilitate hydrotreating, reduce sulfur and for neutralization.
PRO-OXIDENT COPPER CONTAMINATION	**KUPLEX*** Metal Deactivator	prevents copper and compounds thereof from degrading petroleum distillates. It acts by tying-up dissolved metal as an inactive stable chelate. KUPLEX is effective in gasoline, kerosine, jet fuel, diesel fuel, furnace oil and turbine oil.
MERCAPTANS	**PETRECO* BENDER** Catalytic Sweetening	effectively sweetens distillates in the gasoline, kerosine, jet fuel and burning oil range by converting mercaptans to disulfides by oxidation. The process is simple, automatically controlled and continuous. There is no volume loss, no regenerator is required (catalyst life usually exceeds a year or more), and installation costs are moderate. Existing vessels can often be adapted for use.
INSTABILITY	**TOLAD*** Fuel Additives	improve color and residue stability in domestic heating oils and diesel fuels. They possess excellent water tolerance characteristics, reducing sludge formation and losses to water bottoms in storage. TOLAD Fuel Additives are available as inhibitor or inhibitor-dispersant formulations.
REFINERY WASTES	**TRET-O-LITE*** Water De-oiler Chemicals	are used to demulsify waste oil emulsions, making possible the salvage of usable oil and, at the same time, insuring against stream or harbor pollution. They are used in conjunction with conventional slops disposal and separator systems.

*PETRECO, TRET-O-LITE, KONTOL, KUPLEX and ELECTROFINING are registered trademarks of Petrolite Corporation

Petrolite Limited chemicals and processes are available for purchase in Pounds Sterling.

TECHNICAL ASSISTANCE—The Petrolite engineering staff is available to assist you with the proper application of the above-described products and processes. For additional information, write or call . . .

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JAPAN: (Petreco) Tokyo, Chiyoda Chemical Engineering and Construction Company, Ltd., Tokyo Building, No. 3, Marunouchi 2-Chome, Chiyoda-Ku
(Tretolite) Tokyo, Maruwa Bussan, KK, No. 3, 2-Chome, Kyobashi, Chuo-Ku

Oil Refineries of the World (Continued from page 51)

Country	No. of Plants	Year	Crude Capacity	Thermal Capacity	Catalytic Operations: Cracking	Reforming	Poly	Hydrogen Processes	Alkylation	Lube
Argentina	16	1959	213.6	87.5	18.4	3.0				1.6
	16	1961	289.6	87.5	35.0	3.0				1.6
	16	1963	289.6	87.5	35.0	3.0				1.6
Bolivia	4	1959	11.8	1.5						0.2
	4	1961	11.8	1.5						0.2
	4	1963	11.8	1.5						0.2
Brazil	8	1959	166.8	18.5	12.5		6.2			3.0
	10	1961	281.3	16.0	17.3		6.7			3.0
	10	1963	281.3	16.0	17.3		6.7			3.0
Chile	2	1959	44.7	9.5	12.0	6.0			1.0	
	2	1961	44.7	9.5	12.0	6.0			1.0	
	2	1963	44.7	9.5	12.0	6.0			1.0	
Colombia	5	1959	70.3	31.0	41.0		1.2		2.3	0.5
	5	1961	70.3	31.0	41.0		1.2		2.3	0.5
	5	1963	70.3	31.0	41.0		1.2		2.3	0.5
Ecuador	2	1959	13.8	6.0						
	2	1961	16.1	6.0						
	2	1963	16.1	6.0						
Peru	3	1959	47.5	14.5						0.5
	3	1961	47.5	14.5						0.5
	3	1963	47.5	14.5						0.5
Uruguay	1	1959	28.0	2.2	0	3.0				
	1	1961	56.0	2.2	5.0	3.0				
	1	1963	56.0	2.2	5.0	3.0				
Venezuela	10	1959	817.7	113.5	41.5	20.0	2.0	17.0	2.3	4.0
	11	1961	920.7	113.5	41.5	20.0	2.0	17.0	2.3	4.0
	11	1963	920.7	113.5	41.5	20.0	2.0	17.0	2.3	4.0
Total South America	51	1959	1,414.2	290.2	125.4	32.0	9.4	17.0	5.6	9.8
	51	1961	1,738.0	281.7	151.8	32.0	9.9	17.0	5.6	9.8
	54	1963	1,738.0	281.7	151.8	32.0	9.9	17.0	5.6	9.8
Total Western Hemisphere	406	1959	13,796.4	2,934.9	3,687.6	1,821.3	170.8	1,767.0	366.6	189.5
	416	1961	14,710.9	2,951.8	3,920.2	1,974.2	176.5	1,973.9	404.6	189.5
	416	1963	15,040.7	2,952.3	4,072.7	2,097.3	178.5	2,223.9	454.6	189.5
Austria	9	1959	44.3	10.8		0				1.9
	6	1961	47.1	4.2		4.3				1.9
	6	1963	64.3	4.2		4.3				1.9
Belgium	7	1959	155.2	11.8	22.6	17.0	3.3	19.7		0.5
	7	1961	235.2	11.8	22.6	17.0	3.3	19.7		0.5
	7	1963	235.2	11.8	22.6	17.0	3.3	19.7		0.5
Denmark	2	1959	0.6		3.3					
	2	1961	0.6		3.3					
	2	1963	0.6		3.3					
France	14	1959	708.3	130.3	112.5	84.4	3.7	57.8	14.0	13.9
	14	1961	726.3	128.1	112.5	86.2	3.7	60.3	14.0	14.3
	16	1963	837.3	128.1	112.5	86.2	3.7	60.3	14.0	14.3
Finland	1	1959	19.2		6.0	3.4	2.0			
	1	1961	19.2		6.0	3.4	2.0			
	1	1963	19.2		6.0	3.4	2.0			
Germany	25	1959	527.5	34.0	61.7	64.6	3.9	75.8		11.7
	27	1961	774.2	32.1	61.7	66.6	3.9	77.2		11.7
	28	1963	898.0	31.3	61.7	66.3	3.9	77.2		11.7
Greece	1	1959	27.0		7.4					
	1	1961	27.0		7.4					
	1	1963	27.0		7.4					
Ireland	1	1959	20.0							
	1	1961	40.0							
	1	1963	40.0							
Italy	37	1959	799.2	78.3	39.6	92.0	7.3	54.7		7.1
	38	1961	860.5	78.3	42.1	93.4	7.3	54.7		7.1
	38	1963	860 5	78.3	42.1	93.4	7.3	54.7		7.1
Netherlands	2	1959	354.4	44.4	66.0	19.7	7.1	26.0	2.5	2.9
	3	1961	495.0	46.7	66.0	26.9	7.1	26.0	2.5	2.9
	3	1963	495.0	46.7	66.0	26.9	7.1	26.0	2.5	2.9
Norway	1	1959	2.0							0.3
	3	1961	82.0							0.3
	3	1963	82.0							0.3
Portugal	1	1959	21.6		9.5		1.3			0.2
	1	1961	27.0		9.5		1.3			0.2
	1	1963	27.0		9.5		1.3			0.2
Spain	2	1959	134.1	14.2		15.6	1.6	0		1.0
	2	1961	149.6	14.2		15.6	1.6	4.6		1.0
	2	1963	149.6	14.2		15.6	1.6	4.6		1.0
Sweden	4	1959	53.2	6.6		11.2	0.2	0		
	4	1981	72.1	6.6		11.2	0.2	7.2		
	4	1963	72.1	6.6		11.2	0.2	7.2		
United Kingdom	14	1959	807.6	54.3	123.3	70.2	10.7	44.8	2.0	19.4
	16	1961	984.6	54.3	123.3	89.7	10.7	73.1	2.0	20.7
	16	1963	1,030.1	54.3	123.3	89.7	10.7	73.1	2.0	20.7
Yugoslavia	3	1959	22.7	2.4	4.0	0		0		0.8
	3	1961	34.1	2.4	4.0	2.0		0		1.2
	4	1963	56.0	2.4	15.0	5.5		6.3		1.6
Total Western Europe	124	1959	3,696.9	377.1	455.9	378.1	41.1	278.8	18.5	61.1
	129	1961	4,564.5	378.7	458.4	416.0	41.1	322.8	18.5	63.7
	133	1963	4,893.9	377.9	469.4	419.5	41.1	329.1	18.5	64.1
Communist Bloc	NA	1959	2,612.0	NA	NA	NA	NA	NA	NA	NA
	NA	1961	3,667.0	NA	NA	NA	NA	NA	NA	NA
	NA	1963	4,957.0	NA	NA	NA	NA	NA	NA	NA
Total Europe*	124	1959	6,308.9	377.1	455.9	368.1	41.1	278.8	18.5	61.1
	129	1961	8,231.5	378.7	458.4	416.0	41.1	322.8	18.5	63.7
	133	1963	9,850.9	377.9	469.4	419.5	41.1	329.1	18.5	64.1
Aden	1	1959	100.0	10.8		10.8				
	1	1961	100.0	10.8		10.8				
	1	1963	100.0	10.8		10.8				
Bahrain	1	1959	186.5	32.4	24.6	11.0	1.8	15.0	0.7	
	1	1961	186.5	32.4	24.6	11.0	1.8	15.0	1.2	
	1	1963	186.5	32.4	24.6	11.0	1.8	15.0	1.2	
Egypt	3	1959	77.5	10.8		1.3	0.5	4.8		0.2
	3	1961	99.0	10.8		1.3	0.5	4.8		1.2
	3	1963	99.0	10.8		1.3	0.5	4.8		1.2
Iran	4	1959	485.2	74.3	27.0		1.3	1.3	9.9	0.4
	4	1961	491.2	74.3	27.0		1.3	1.3	9.9	0.4
	4	1963	491.2	74.3	27.0		1.3	1.3	9.9	0.4
Iraq	6	1959	58.7	16.7		1.5				0.5
	6	1961	72.3	16.7		4.5				0.5
	6	1963	72.3	16.7		4.5				0.5
Israel	1	1959	84.0	38.0						
	1	1961	84.0	38.0						
	1	1963	84.0	38.0						
Jordan	1	1959	0.6							
	1	1961	0.6							
	1	1963	0.6							
Kuwait	2	1959	201.0			3.8				
	2	1961	201.0			3.8				
	2	1963	201.0			3.8				
Lebanon	1	1959	23.2			0				
	2	1961	23.2			3.1				
	2	1963	23.2			3.1				
Neutral Zone	1	1959	50.0							
	1	1961	50.0							
	1	1963	50.0							
Qatar	1	1959	0.6							
	1	1961	0.6							
	1	1963	0.6							
Saudi Arabia	1	1959	219.0	25.0		14.0	1.0	15.0	0.7	
	1	1961	219.0	25.0		14.0	1.0	15.0	1.2	
	1	1963	219.0	25.0		14.0	1.0	15.0	1.2	

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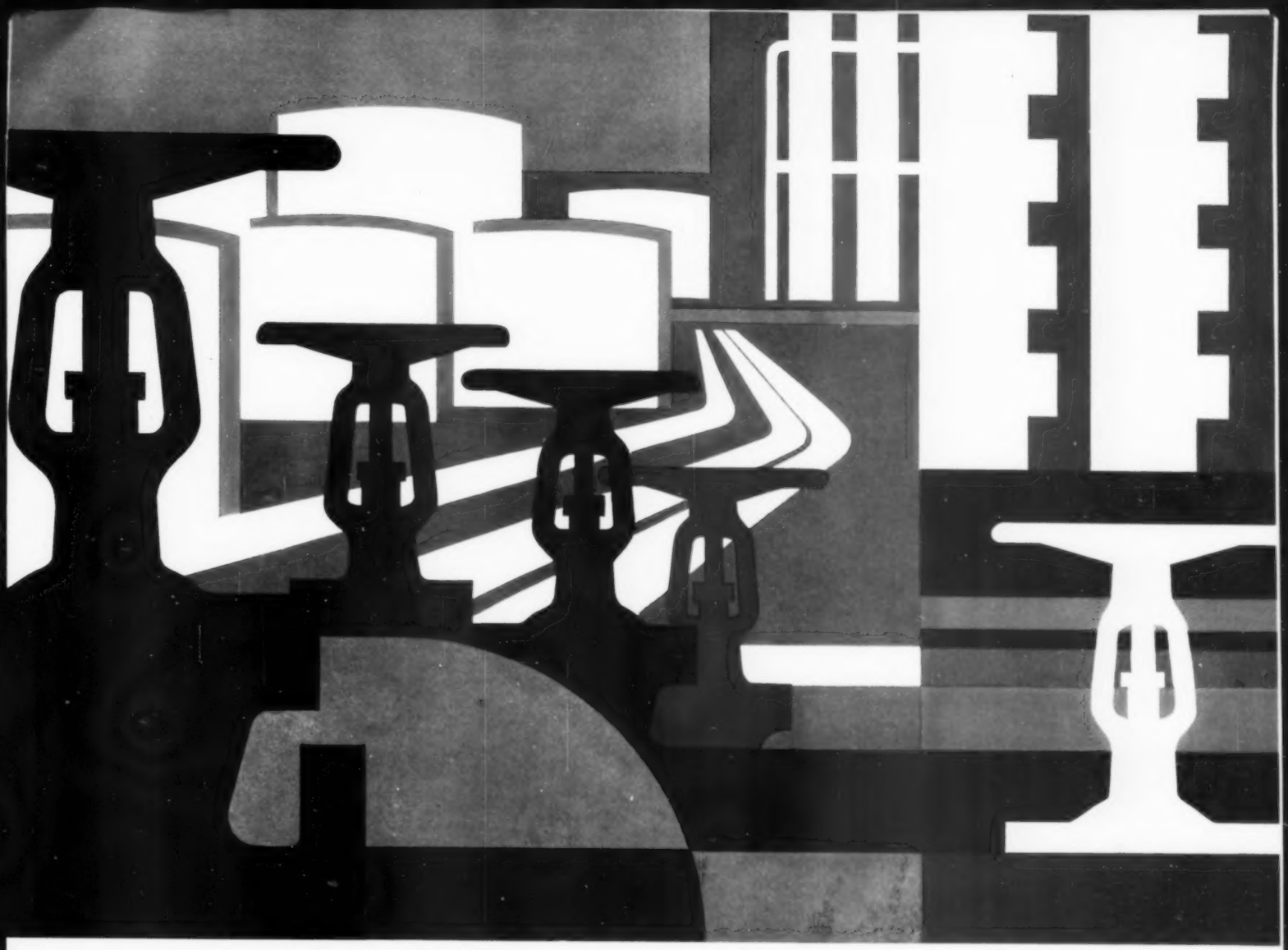

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Country	No. of Plants	Year	Crude Capacity	Thermal Capacity	Catalytic Operations: Cracking	Reforming	Poly	Hydrogen Processes	Alky-lation	Lube
Syria	1	1959	10.0							
	1	1961	20.0							
	1	1963	20.0							
Turkey	1	1959	6.3		2.0			0	0	
	1	1961	6.3		2.0			0	0	
	1	1963	74.1		6.7			7.2	7.3	
Total Middle East	25	1959	1,502.6	208.0	53.6	44.8	5.2	19.5	10.6	0.9
	26	1961	1,553.7	208.0	53.6	54.0	5.2	24.3	11.1	2.7
	27	1963	1,621.5	208.0	58.3	61.2	5.2	31.6	11.1	2.7
Angola	1	1959	2.6							
	1	1961	3.0							
	1	1963	3.0							
Algeria	0	1959	0							
	1	1961	40.0							
	1	1963	40.0							
Morocco	1	1959	2.4		3.5					
	1	1961	2.4		3.5					
	1	1963	2.4		3.5					
Mozambique	0	1959	0							
	0	1961	0							
	1	1963	10.0							
S. Africa	1	1959	23.0	2.0	10.0	5.0	0.3	6.0		
	1	1961	25.0	2.0	10.0	5.0	0.3	6.0		
	2	1963	106.0	2.0	10.0	5.0	0.3	6.0		
Total Africa	3	1959	28.0	2.0	13.5	5.0	0.3	6.0		
	4	1961	80.0	2.0	13.5	5.0	0.3	6.0		
	6	1963	161.4	2.0	13.5	5.0	0.3	6.0		
Australia	7	1959	239.5		57.5	31.1	4.3	23.9	1.7	0.8
	7	1961	246.5		57.5	31.1	4.3	26.9	1.7	0.8
	8	1963	281.5		57.5	31.1	4.3	26.9	1.7	0.8
British Borneo	1	1959	44.0							
	1	1961	44.0							
	1	1963	44.0							
Burma	2	1959	4.5							
	2	1961	4.5							
	2	1963	4.5							
Ceylon	0	1959	0							
	0	1961	0							
	1	1963	32.0							
India	4	1959	110.0	5.7	27.5	6.7	1.1			0.1
	4	1961	112.3	5.7	27.5	6.7	1.1			0.1
	5	1963	168.3	5.7	27.5	6.7	1.1			0.1
Indonesia	6	1959	259.8	59.0	10.0		1.9		6.1	
	6	1961	259.8	59.0	10.0		1.9		6.1	
	6	1963	259.8	59.0	10.0		1.9		6.1	
Japan	25	1959	490.0	9.6	48.6	33.9		23.5	1.5	14.7
	27	1961	569.0	11.6	59.0	42.9		23.5	1.5	14.7
	29	1963	674.0	11.6	74.0	51.7		23.5	1.5	14.7
Pakistan	1	1959	5.0							
	1	1961	5.0							
	2	1963	37.0							
Philippine Is.	1	1959	22.0		5.4		1.5			
	2	1961	60.0		5.4		1.5			
	3	1963	91.0		11.4		1.5			
Taiwan	1	1959	21.0	3.8	10.2	2.5				0.6
	1	1961	21.0	3.8	10.2	2.5				1.0
	1	1963	21.0	3.8	10.2	2.5				1.0
Thailand	1	1959	1.0							
	1	1961	1.0							
	2	1963	6.0							
Communist China	NA	1959	50.0							
	NA	1961	60.0							
	NA	1963	70.0							
Total Asia*	49	1959	1,255.3	78.1	159.2	74.2	8.8	47.4	9.3	16.2
	52	1961	1,394.6	80.1	169.5	83.2	8.8	50.4	9.3	16.6
	60	1963	1,700.6	80.1	190.6	92.0	8.8	50.4	9.3	16.6
Total Eastern Hemisphere	201	1959	9,142.7	665.2	682.2	502.1	55.4	351.7	38.4	78.2
	211	1961	11,048.3	668.8	695.0	558.2	55.4	403.5	38.9	83.0
	225	1963	13,322.9	668.0	731.8	567.7	55.4	417.1	38.9	83.4
World Total	607	1959	22,939.1	3,600.1	4,369.8	2,323.4	226.2	2,118.7	405.0	267.7
	627	1961	25,979.2	3,620.6	4,615.2	2,532.4	231.9	2,377.4	443.5	272.5
	641	1963	28,363.6	3,620.3	4,804.5	2,665.0	233.9	2,641.0	493.5	272.9

* World Total, Total Asia and Total Europe does not include Communist countries with the exception of Crude Capacity

Detail by Companies

Name of Company & Location	Year	Crude Capacity	Thermal Capacity	Catalytic Operations: Cracking	Reforming	Poly	Hydrogen Processes	Alky-lation	Lube
ADEN									
British Petroleum	1959	100.0	10.8		10.8		3.2		
Aden	1961	100.0	10.8		10.8		3.2		
	1963	100.0	10.8		10.8		3.2		
AFRICA (South)									
Shell	1959	0							
Durban	1961	0							
	1963	80.0							
Shell has also reported considering location in Mombassa, Kenya									
Standard Vacuum Ref. Co.	1959	23.0	2.0	10.0	5.0	0.3	6.0		
Durban	1961	25.0	2.0	10.0	5.0	0.3	6.0		
	1963	26.0	2.0	10.0	5.0	0.3	6.0		
Sonap de Mozambique	1959	0							
Laurenco Marques	1961	0							
	1963	10.0							
ALGERIA									
Soc. de la Raffinerie	1959	0							
D'Alger	1961	40.0							
Algiers	1963	40.0							
ANGOLA									
Purfina,	1959	2.6							
Luanda	1961	3.0							
	1963	3.0							
ARGENTINA									
Cia. Condor	1959	0.9							
Avellaneda	1961	0.9							
	1963	0.9							
Cia. General Asfaltos	1959	0.4							
Wilde (B.A.)	1961	0.4							
	1963	0.4							
Cia. La Isaura SA	1959	1.8	1.0						
Bahia Blanca	1961	1.8	1.0						
	1963	1.8	1.0						
Diadema Argentina SA de	1959	23.0	26.0		3.0				0.6
Petroleo	1961	43.0	26.0		3.0				0.6
Buenos Aires	1963	43.0	26.0		3.0				0.6
Esso S.A.P.A., SA	1959	5.5	2.5						
Bahia Blanca	1961	5.5	2.5						
	1963	5.5	2.5						
Esso S.A.P.A., SA*	1959	25.0	11.0						1.0
Campana	1961	25.0	11.0						1.0
	1963	25.0	11.0						1.0
* Proposed 13.3 FCC & 40.0 TBD Crude still. No date.									
Esso S.A.P.A., SA	1959	1.3							
Manuel Elordi (Salti)	1961	1.3							
	1963	1.3							
Esso S.A.P.A., SA	1959	0.5							
Plaza, Munical	1961	0.5							
	1963	0.5							

(Continued)

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Name of Company & Location	Year	Crude Capacity	Thermal Capacity	Catalytic Operations: Cracking	Reforming	Poly	Hydrogen Processes	Alky-lation	Lube
Lottero Y. Papini	1959	0.5							
Avellaneda	1961	0.5							
	1963	0.5							
YPF	1959	3.5	1.3						
Chachapoyas (Salta)	1961	3.5	1.3						
	1963	3.5	1.3						
YPF	1959	5.5	2.0						
Comodoro Rivadavia	1961	5.5	2.0						
	1963	5.5	2.0						
YPF	1959	5.5	3.0						
Dock-Sud-Avellaneda	1961	5.5	3.0						
	1963	5.5	3.0						
YPF	1959	95.0	25.0		18.4	*			*
La Plata	1961	123.0	25.0		18.4	*			*
	1963	123.0	25.0		18.4	*			*
* Capacities of these units not available.									
YPF	1959	23.9	9.0		0.6				
Lujan de Cuyo (Mendoza)	1961	51.9	9.0		16.6				
	1963	51.9	9.0		16.6				
YPF	1959	2.5	0.5						
Plaza Municul (Neuquen)	1961	2.5	0.5						
	1963	2.5	0.5						
YPF	1959	18.8	6.2						
San Lorenza	1961	18.8	6.2						
	1963	18.8	6.2						
AUSTRALIA									
Australian Oil Refinery	1959	42.0		15.0		1.5			
Kurnell, NSW	1961	45.0		15.0		1.5			
	1963	45.0		15.0		1.5			
Boral	1959	15.0			2.3		7.3		
Sydney, NSW	1961	15.0			2.3		7.3		
	1963	15.0			2.3		7.3		
Boral	1959	2.0							
Brisbane, Queensland	1961	2.0							
	1963	2.0							
B. P. Refinery	1959	70.0		12.5	10.0		5.6		
Kwiana, W. Australia	1961	70.0		12.5	10.0		5.6		
	1963	70.0		12.5	10.0		5.6		
Shell Oil Co. of Australia	1959	17.5			6.7				0.3
Clyde, NSW	1961	17.5			6.7				0.3
	1963	17.5			6.7				0.3
Shell Refinery	1959	46.0		15.0	6.7	2.8	11.0		
Geelong, Victoria	1961	46.0		15.0	6.7	2.8	11.0		
	1963	46.0		15.0	6.7	2.8	11.0		
Standard Vacuum Ref. Co.	1959	0					0	1.7	0.5
Adelaide, S. Australia	1961	0					3.0	1.7	0.5
	1963	35.0					3.0	1.7	0.5
Standard Vacuum Ref. Co.	1959	37.0		15.0	5.4				
Altona, Victoria	1961	41.0		15.0	5.4				
	1963	41.0		15.0	5.4				
AUSTRIA									
A. G. de Shell-Florisdsdorfer	1959	4.5							1.0
Mineraloel Fabrik	1961	4.5							1.0
Floridsdorf (Vienna)	1963	4.5							1.0
Klederinger Mineraloel	1959	0.4							
Raffinerie	1961	0.4							
Kledering (Vienna)	1963	0.4							
Oesterreichische Mineraloel	1959	6.3							
Verwaltng A. G.	1961	0							
(OMVAG), Korneuburg	1963	0							
To be shut down									
OMVAG	1959	6.5	5.4						
Mossbierbaum	1961	0	0						
	1963	0	0						
To be shut down									
OMVAG	1959	12.6	5.4		0				0.7
Schwechat (Vienna)	1961	30.7	4.2		4.3				0.7
	1963	47.9	4.2		4.3				0.7
OMVAG	1959	2.5							
Voesendorg (Vienna)	1961	0							
	1963	0							
To be shut down. It is in process of being dismantled.									
Oesterreichische Mineral-oelwerke (OMW)	1959	7.2							
	1961	7.2							
Lobau (Vienna)	1963	7.2							
Refinery is leased indefinitely to the gov't.									
Richard K. Van Sickle	1959	0.9							
Neusied Zaya	1961	0.9							
	1963	0.9							
Vacuum Oil Co. A. G.	1959	3.4							0.2
Kagran (Vienna)	1961	3.4							0.2
	1963	3.4							0.2
BAHRAIN									
Bahrain Petroleum Co.	1959	186.5	32.4	24.6	11.0	1.8			
Bahrain Island	1961	186.5	32.4	24.6	11.0	1.8			
	1963	186.5	32.4	24.6	11.0	1.8			
BELGIUM									
Albatros Soc. Anonyme	1959	12.6		4.1		0.6			
Belge Pour le Raffinage	1961	12.6		4.1		0.6			
de Petrole, Antwerp	1963	12.6		4.1		0.6			
Belgium Shell Co. S.A.	1959	2.7							0.5
Ghent	1961	2.7							0.5
	1963	2.7							0.5
Esso Belgium S.A.	1959	36.0	3.7	9.5	5.0		6.2		
Antwerp	1961	36.0	3.7	9.5	5.0		6.2		
	1963	36.0	3.7	9.5	5.0		6.2		
Esso Belgium S.A.	1959	2.3							
Hoboken-Antwerp	1961	2.3							
	1963	2.3							
Formerly Cie. Industrielle "Atlas" S.A.									
Raffinerie Belge de Pet-roleos S.A.	1959	16.7	2.7		2.3		4.5		
	1961	16.7	2.7		2.3		4.5		
Antwerp	1963	16.7	2.7		2.3		4.5		
Soc. Industrielle Belge	1959	80.0	5.4	9.0	9.0	2.7	9.0		
des Petroles	1961	160.0	5.4	9.0	9.0	2.7	9.0		
Antwerp	1963	160.0	5.4	9.0	9.0	2.7	9.0		
Tankage & Transport S.A.	1959	4.9			0.7				
Antwerp	1961	4.9			0.7				
	1963	4.9			0.7				
BOLIVIA									
Yacimientos Petroliferos	1959	1.5							
Fiscales Bolivianos (YPFB)	1961	1.5							
Camiri	1963	1.5							
YPFB	1959	5.9			1.5				0.2
Cochabamba	1961	5.9			1.5				0.2
	1963	5.9			1.5				0.2
YPFB	1959	0.4							
Sanandita	1961	0.4							
	1963	0.4							
YPFB	1959	4.0							
Sucre	1961	4.0							
	1963	4.0							
BRAZIL									
Cia De Petroleo de	1959	5.0		2.5					
Amozonia	1961	5.0		2.5					
Manus	1963	5.0		2.5					
Distillaria Rio Grandense	1959	0.3							
de Petroleo, S.A.	1961	0.3							
Rio Grande Du Sul	1963	0.3							
Industrias Matarazzo de	1959	0.5							
Energie, SA	1961	0.5							
Sao Paulo	1963	0.5							

(Continued)

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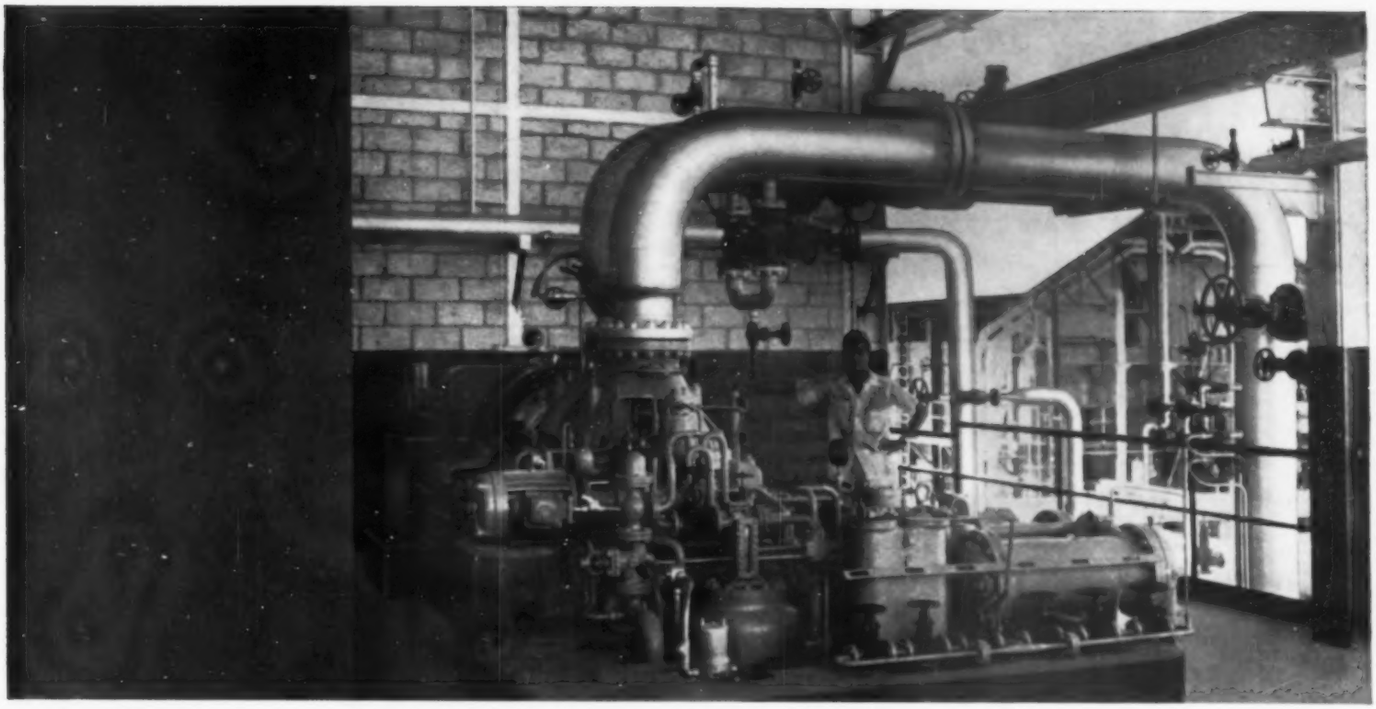
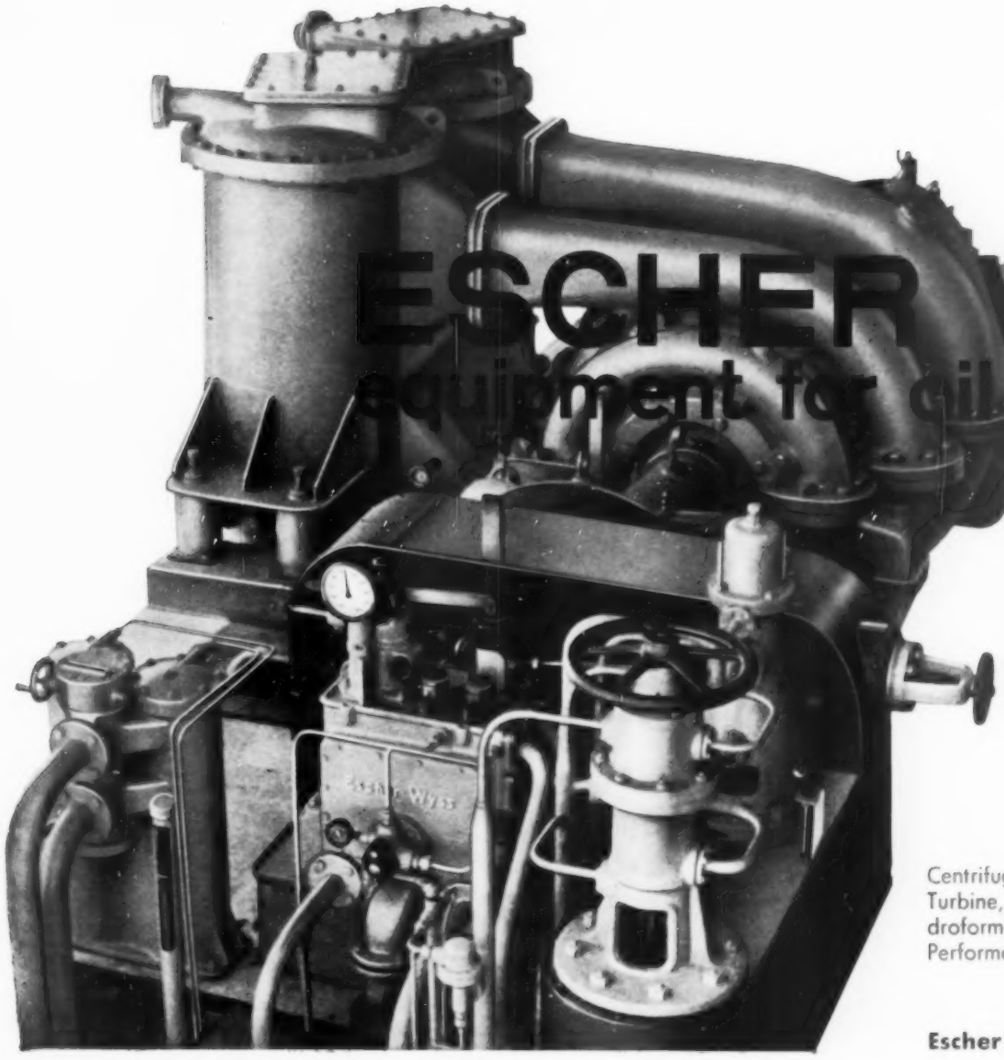
A MEMBER OF THE CONCENTRIC GROUP OF COMPANIES.

Name of Company & Location	Year	Crude Capacity	Thermal Capacity	Catalytic Operations: Cracking	Reforming	Poly	Hydrogen Processes	Alky-lation	Lube
Ipiranga S.A. Cia Brasileira	1959	6.0	2.0						
Rio Grande	1961	6.0	2.0						
	1963	6.0	2.0						
Petrobras	1959	0							
Corumba	1961	2.5							
	1963	2.5							
Petrobras	1959	100.0	17.5			6.0		3.0	
Cubatao	1961	100.0	17.5			6.0		3.0	
	1963	100.0	17.5			6.0		3.0	
Petrobras	1959	0							
Duque de Caxias	1961	90.0							
	1963	90.0							
Petrobras	1959	15.0	2.5	0		0.2		3.0	
Mataripe	1961	37.0	0	4.8		0.7		3.0	
	1963	37.0	0	4.8		0.7		3.0	
Refineria e Exploracao de	1959	10.0	7.0						
Manguinhas	1961	10.0	7.0						
Rio de Janeiro	1963	10.0	7.0						
Refineria e Exploracao de	1959	30.0		10.0					
Petrolea	1961	30.0		10.0					
Sao Paulo	1963	30.0		10.0					
BRITISH BORNEO									
Sarawak Oil Fields Ltd.	1959	44.0							
Lutong, Brunei	1961	44.0							
	1963	55.0							
BURMA									
Burmah Oil Co. Ltd.	1959	4.0							
Chauk	1961	4.0							
	1963	4.0							
Burmah Oil Co., Ltd.	1959	3.5							
Syrian	1961	3.5							
	1963	3.5							
Nathsingh Oil Co., Ltd.									
Yenangyaung	1959	0.5							
	1961	0.5							
	1963	0.5							
CANADA									
Maritimes									
Imperial Oil Ltd.	1959	49.0		17.0	6.3	4.5			
Dartmouth, N.S.									
Irving Refining Ltd.	1959	0		0	0		0		
St. John, N.B.	1961	40.0		13.0	7.2		5.0		
New Brunswick Oilfields Ltd.	1959	0.3							
Total Maritimes	1959	49.3		17.0	6.3	4.5			
	1961	89.3		30.0	13.5	4.5	5.0		
	1963	98.3		46.0	15.0	4.5	5.0		
Quebec									
B.P. Canada Ltd.	1959	0		0	0	0	0		
Montreal	1961	25.0		9.0	6.0	0.8	12.0		
Canadian Petrofinia Ltd.	1959	30.0	3.8	19.0	4.5	0.3	9.0	1.5	
Montreal									
Imperial Oil Ltd.	1959	71.8	10.5	19.5	9.4	2.5	7.0		
Montreal									
Shell Oil Co. of Can. Ltd.	1959	60.0	8.0	20.5	8.0	1.2	9.0	1.5	
Montreal									
Texaco Can. Ltd.	1959	59.0	12.0	20.0	11.0	1.5	20.0		
Montreal									
British American Oil Co.	1959	45.0	0	19.8	11.7	0.6	15.6		0.3
Montreal									
Total Quebec	1959	265.8	34.3	98.8	44.6	6.1	60.5	3.3	0.3
	1961	311.0	34.3	131.0	56.5	6.9	72.5	3.0	0.3
	1963	311.0	34.3	131.0	56.5	6.9	72.5	3.0	0.3
Ontario									
British American Oil Co.	1959	55.4	4.0	17.6	9.0	1.1	12.0		1.2
Clarkson									
Canadian Husky Oil Ltd.	1959	3.8			1.0		1.0		
Fort William									
Canadian Oil Cos. Ltd.	1959	50.0	4.0	12.0	10.0	1.7			
Corunna									
Cities Service Ref. Co.	1959	18.6		6.0	3.5				
of Canada, Bronte									
Imperial Oil Ltd.	1959	87.5	18.0	19.3	13.5		4.0		3.2
Sarnia									
Regent Refining (Can.) Ltd.	1959	20.0	3.6	7.0	2.1	0.7			
Port Credit									
Sun Oil Co. Ltd.	1959	15.0		11.5	3.0				
Sarnia									
Total Ontario	1959	250.3	29.6	73.4	42.1	2.5	17.0		4.4
	1961	270.0	29.6	92.8	54.0	4.1	17.0		4.4
	1963	350.0	29.6	121.6	70.0	4.1	17.0		4.4
Manitoba									
Anglo Canadian Oil Co. Ltd.	1959	2.7	1.4		1.2	0.1			
Brandon									
Imperial Oil Ltd.	1959	18.0		6.0	3.2			0.7	
Winnipeg									
North Star Oil Ltd.	1959	12.0		5.2	2.7	0.5			
Total Manitoba	1959	32.7	1.4	11.2	6.4	0.6		0.7	
	1961	37.2	1.4	14.2	7.9	0.6		0.7	
	1963	44.2	1.4	17.2	9.2	0.6		0.7	
Saskatchewan									
British American Oil Co.	1959	13.5	1.4	4.0	4.9	0.4	6.3		
Moose Jaw									
Canadian Husky Oil Ltd.	1959	3.2	1.3		0.7		1.0		
Moose Jaw									
Consumers' Co-operative	1959	16.0	3.0	5.0		0.6			
Refineries Ltd., Regina									
Imperial Oil Ltd., Regina	1959	22.5	4.5	8.5	3.0	2.0			
Northern Pet. Corp. Ltd.	1959	1.0							
Kamsack									
Petroleum Fuels Ltd.	1959	1.1							
Moose Jaw									
Royalite Highway Ltd.	1959	6.2	3.8	2.6		0.2	1.6		
Saskatoon									
Total Saskatchewan	1959	63.3	13.0	20.1	8.6	3.2	8.9		
	1961	67.8	18.0	27.5	8.6	3.2	8.9		
	1963	67.8	18.0	27.5	8.6	3.2	8.9		
Alberta									
Anglo American Expl. Ltd.	1959	4.0	1.4		1.0	0.6			
Hartell									
British American Oil Co.	1959	6.8	2.5		2.0				
Calgary									
British American Oil Co.	1959	7.7	1.4	2.0	5.4		6.3		
Edmonton									
Canadian Husky Oil Ltd.	1959	7.8			0.4		1.0		
Lloydminster									
Imperial Oil Ltd., Calgary	1959	14.0	4.6	7.0	3.0			0.9	
Imperial Oil Ltd, Edmonton	1959	28.5	9.1	8.0	2.0		2.9		2.0
North Star Oil Ltd.	1959	2.5	1.0		0.9		0.9		
Grand Prairie									
Texaco Can. Ltd., Edmonton	1959	12.0	2.7	4.0	3.0	0.5			
Wainwright Producers &	1959	4.5							
Ref. Ltd., Wainwright									
Total Alberta	1959	83.8	22.7	21.0	17.7	1.1	11.7	0.9	2.0
	1961	107.8	30.7	24.4	25.0	1.1	11.7	2.4	2.0
	1963	117.1	31.2	26.9	26.8	1.1	11.7	2.4	2.0
British Columbia									
British American Oil Co.	1959	20.0		9.0	4.0		7.2	1.1	
Ltd., Port Moody									
Imperial Oil Ltd., Vancouver	1959	34.0		7.6	5.0	1.1	3.8		
Pacific Petroleums Ltd.	1959	3.0			2.0		0.5		
Taylor									
Royalite Oil Co. Ltd.	1959	5.0		1.4	1.0	0.1			
Kamloops									
Shell Oil Co. of Canada	1959	22.0	4.5	6.0	2.5	0.4	11.8		
Ltd., Shellburn									
Standard Oil Co.of B. C.	1959	18.0		4.5	2.4	0.5			
Ltd. Vancouver									
X-L Refineries Ltd.	1959	2.5	0.8		0.5				
Dawson Creek									
Total British Columbia	1959	104.5	5.3	29.9	15.9	2.1	23.3	1.1	
	1961	104.5	5.3	37.7	18.6	2.1	23.3	1.1	
	1963	114.0	5.3	41.7	21.1	2.1	23.3	1.1	
Northwest Territories									
Imperial Oil Ltd.	1959	1.3							
Norman Wells									
Total Canada	1959	851.0	106.3	271.4	141.6	20.1	141.5	5.7	6.7
	1961	988.9	119.3	357.6	184.1	22.5	138.4	7.2	6.7
	1963	1,103.7	119.8	410.1	207.2	22.5	138.4	7.2	6.7
CEYLON									
BP & Shell, 60%, Stanvac	1959	0							
20%, Caltex 20%.	1961	0							
Colombo	1963	22.0							

(Continued)



Centrifugal Recycle Gas Compressor with sealing oil system, installed in an oil refinery



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Centrifugal Compressor with Condensing Steam Turbine, supplying combustion air to a fluid hydroformer installed in an oil refinery.
Performance: 11,250 cfm, 260 psia, 8150 rpm

Escher Wyss Ltd. Zurich/Switzerland

Name of Company & Location	Year	Crude Capacity	Thermal Capacity	Catalytic Operations: Cracking	Reforming	Poly	Hydrogen Processes	Alky-lation	Lube
CHILE									
E.N.A.P.	1959	44.0	9.5	12.0	6.0			1.0	
Concon	1961	44.0	9.5	12.0	6.0			1.0	
	1963	44.0	9.5	12.0	6.0			1.0	
E.N.A.P.	1959	0.7							
Manatiales	1961	0.7							
	1963	0.7							
COLOMBIA									
Colombian Pet. Co.	1959	2.2							
Tibu	1961	2.2							
	1963	2.2							
Empresa Colombiana de	1959	36.5	16.5	16.0				1.3	0.5
Petroleos	1961	36.5	16.5	16.0				1.3	0.5
Barranca Bermeja	1963	36.5	16.5	16.0				1.3	0.5
Empresa Colombiana de	1959	4.0							
Petroleos	1961	4.0							
La Dorada	1963	4.0							
Empresa Colombiana de	1959	26.5	14.5	25.0		1.7		1.0	
Petroleos	1961	26.5	14.5	25.0		1.2		1.0	
Cartegena	1963	26.5	14.5	25.0				1.0	
The Texas	1959	1.1							
Guama	1961	1.1							
	1963	1.1							

Communist Nations

Information on refining capacities of nations in the Communist Group is not readily available since official government statements normally are given in percentages of increase from an undisclosed base. In the USSR the present 7-year plan envisages an increase of 330% in crude capacity; 1,600-1,800% in reforming capacity and 100% in lube capacity. Current construction in progress is said to total 1,300,000 b/d. Most new plants have capacities of 30,000 to 50,000 b/d. Construction is said to be underway at Omsk, Yaroslavl, Ryazan, Kazan, Fergana, Argorsk, Kasnoyarsk, Pavlodar, Potols, Gomel, Chernikovsk, Novo Kubitchev and Bryansk.

Export pipeline are being laid to deliver Russian crude in rather large quantities to Czechoslovakia, Hungary and Poland where new refineries are planned for completion before 1965.

Following are estimates of crude capacity for various countries in the bloc for the period under review.

Barrels per Calendar Day

	1959	1961	1963-5
Albania	6,000	6,000	46,000
Bulgaria	2,000	2,000	22,000
China	50,000	60,000	70,000
Czechoslovakia	30,000	80,000	130,000
Hungary	34,000	34,000	94,000
East Germany	35,000	35,000	65,000
Poland	150,000	120,000	160,000
Romania	240,000	240,000	240,000
USSR	2,250,000	3,150,000	4,200,000
Total	2,662,000	3,727,000	5,027,000

Name of Company & Location	Year	Crude Capacity	Thermal Capacity	Catalytic Operations: Cracking	Reforming	Poly	Hydrogen Processes	Alky-lation	Lube
CUBA									
Cia Petrolera Shell	1959	27.0			5.0				
Havana	1961	27.0			5.0				
	1963	27.0			5.0				
Copetrol Oil Ref. Co.	1959	0							
Cardena (nr. Nueritas)	1961	18.0							
	1963	18.0							
Corporation General de	1959	1.0							
Petroleo Refineria	1961	1.0							
Cabaiguan, Jatibanico	1963	1.0							
Esso Standard Oil Co. SA	1959	35.0		22.0	2.4	1.0	2.4		0.2
Belot	1961	35.0		22.0	2.4	1.0	2.4		0.2
	1963	35.0		22.0	2.4	1.0	2.4		0.2
Petrolera Jarahueca SA	1959	0.2							
Jarahueca	1961	0.2							
	1963	0.2							
Refinadora Cabaiguan SA	1959	2.0	0.6						
Cabaiguan	1961	2.0	0.6						
	1963	2.0	0.6						
The Texas Co.	1959	20.0			3.3		8.1		
Santiago	1961	20.0			3.3		8.1		
	1963	20.0			3.3		8.1		
DENMARK									
A. P. Moller	1959	0		3.3					
Copenhagen	1961	0		3.3					
	1963	0		3.3					
Oil pyrolysis plant									
A. S. Kalundborg	1959	0.6							
Kalundborg	1961	0.6							
	1963	0.6							

Name of Company & Location	Year	Crude Capacity	Thermal Capacity	Catalytic Operations: Cracking	Reforming	Poly	Hydrogen Processes	Alky-lation	Lube
ECUADOR									
Anglo Ecuadorian Oil	1959	13.3	6.0						
Field Ltd.	1961	15.6	6.0						
La Libertad	1963	15.6	6.0						
Manabi Expl. Co.	1959	0.5							
Cautiro	1961	0.5							
	1963	0.5							
EGYPT									
Anglo-Egyptian Oil Fields	1959	47.0	7.2						
Ltd.	1961	47.0	7.2						
Suez	1963	47.0	7.2						
Raffinerie de Petrole du	1959	26.0	3.6			0.5	4.8		0
Gov't.	1961	26.0	3.6			0.5	4.8		1.2
Suez	1963	26.0	3.6			0.5	4.8		1.2
Societe Egyptienne Pourle	1959	4.5			1.3				
Raffinage et le Commerce	1961	26.0			1.3				
du Petrole, Mex., Alexan.	1963	26.0			1.3				
FINLAND									
Neste Oy	1959	19.2		6.0	3.4	2.0			
Turku	1961	19.2		6.0	3.4	2.0			
	1963	19.2		6.0	3.4	2.0			
FRANCE									
Antar Petroles de	1959	42.0	5.0	20.0	11.0	0.4			0.4
l'Atlantique	1961	50.0	5.0	20.0	11.0	0.4			0.4
Donges	1963	50.0	5.0	20.0	11.0	0.4			0.4
Antar Petroles de	1959	4.2							0.5
l'Atlantique	1961	4.2							0.5
Merkwiller	1963	4.2							0.5
Caltex	1959	23.0	4.3	4.6		0.4			
Bec D'Ambes	1961	23.0	4.3	4.6		0.4			
	1963	23.0	4.3	4.6		0.4			
Cie. Francaise de Raffinage	1959	72.0	30.3	28.0		1.9			2.5
Gonfreville	1961	72.0	30.3	28.0		1.9			2.5
	1963	72.0	30.3	28.0		1.9			2.5
Cie. Francaise de Raffinage	1959	117.5	21.2	11.6	20.0	1.0	20.5		
La Mede	1961	117.5	21.2	11.6	20.0	1.0	20.5		
La Mede	1963	117.5	21.2	11.6	20.0	1.0	20.5		
Esso Standard SAF	1959	35.0			3.0				
Bordeaux	1961	35.0			3.0				
	1963	35.0			3.0				
Esso Standard SAF	1959	85.0	14.6	11.6	14.5		7.8	12.0	4.3
Port Jerome	1961	85.0	14.6	11.6	14.5		7.8	12.0	4.3
	1963	85.0	14.6	11.6	14.5		7.8	12.0	4.3
Mobil Francaise	1959	27.0	2.2	12.7	1.9		2.5		
Frontignan	1961	27.0	0	12.7	3.7		5.0		
	1963	27.0	0	12.7	3.7		5.0		
Mobil Francaise	1959	21.5	2.3		3.9		5.0		2.8
Gravenchon	1961	22.5	2.3		3.9		5.0		2.8
	1963	22.5	2.3		3.9		5.0		2.8
Cie de Raf. Shell Berre	1959	16.0							
Pauillac	1961	16.0							
	1963	16.0							
Cie de Raf. Shell Berre	1959	76.0	15.7	11.0	14.0		11.0		
Berre	1961	76.0	15.7	11.0	14.0		11.0		
	1963	76.0	15.7	11.0	14.0		11.0		
Cie de Raf. Shell Berre	1959	65.0	8.5	13.0			11.0		1.8
Petite Couronne	1961	65.0	8.5	13.0			11.0		1.8
	1963	65.0	8.5	13.0			11.0		1.8
Cie de Raf. Shell Berre	1959	0							
Strasbourg-Colmar	1961	0							
	1963	60.0							
Soc. Francaise des	1959	44.0	7.1		10.0			2.0	2.0
Petroles B.D.	1961	44.0	7.1		10.0			2.0	2.0
Dunkirk	1963	44.0	7.1		10.0			2.0	2.0
Soc. Francaise des	1959	84.0	5.4		6.1				
Petroles B.D.	1961	84.0	5.4		6.1				
Lavera	1963	84.0	5.4		6.1				

(Continued)

M·A·N

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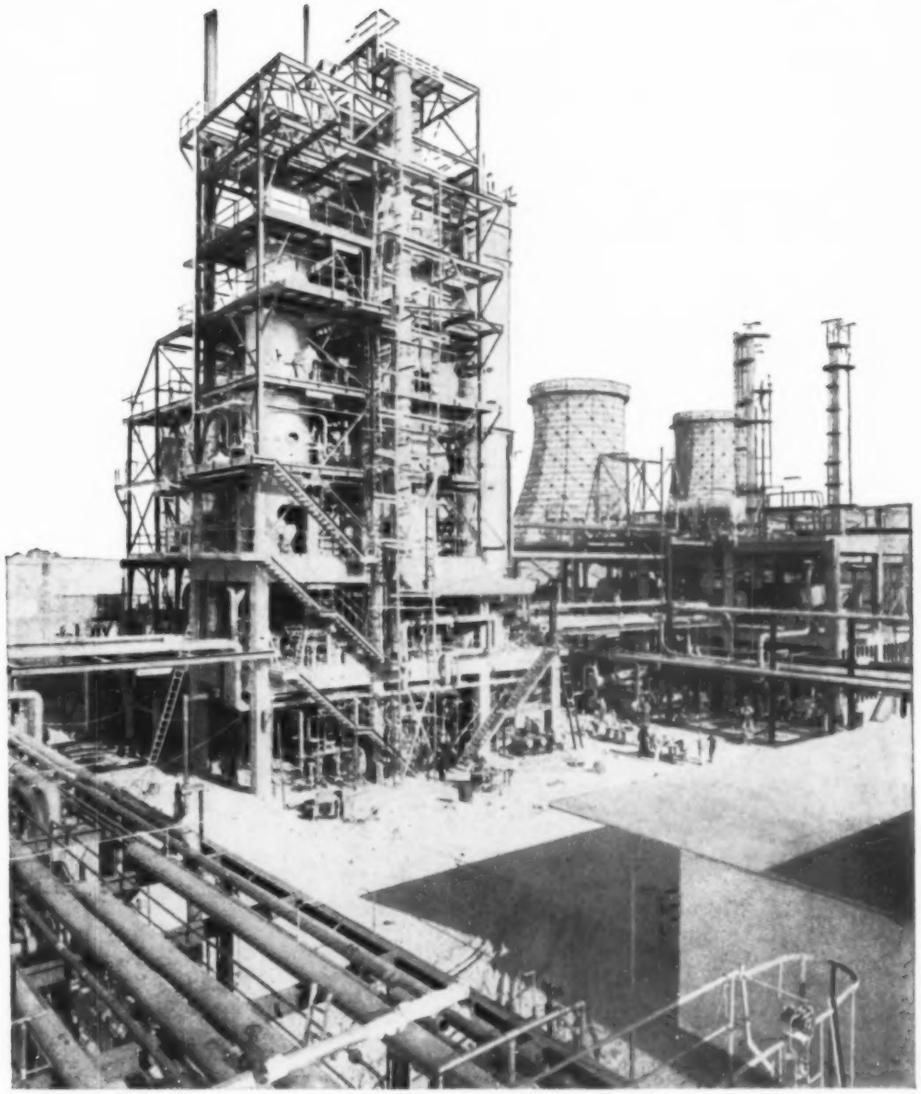

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MASCHINENFABRIK AUGSBURG-NÜRNBERG AG. GERMANY

Name of Company & Location	Year	Crude Capacity	Thermal Capacity	Catalytic Operations: Cracking	Reforming	Poly	Hydrogen Processes	Alky-lation	Lube
Unknown	1959	0							
Strasbourg	1961	0							
	1963	60.0							
GERMANY									
Badische Anilin-und Soda	1959	1.0							0.2
Fabrik, A.G.	1961	1.0							0.2
Ludwigshafen/Rhein	1963	1.0							0.2
Reported to be shutdown. However a cracking plant is being constructed and will probably require crude during the first half of 1959.									
B. P. Benzin & Pet. A.G.	1959	0							
Dinslaken	1961	90.0							
	1963	90.0							
B. P. Benzin & Pet. A.G.	1959	40.0	7.6		5.8		5.7		
Hamburg	1961	40.0	7.6		5.8		5.7		
	1963	40.0	7.6		5.8		5.7		
B. P. Benzin & Pet. A.G.	1959								0.7
Peine-Hanover	1961								0.7
	1963								0.7
Formerly Julius Schindler G.m.b.H.									
B. P. Benzin & Pet. A.G.	1959	4.4							0.7
Hamburg	1961	4.4							0.7
	1963	4.4							0.7
Formerly Julius Schindler G.m.b.H.									
Deutsche Erdoel A.G.	1959	30.0		7.0	3.7*	0.4			1.5
Heide/Holstein	1961	30.0		7.0	3.7	0.4			1.5
	1963	31.0		7.0	3.7	0.4			1.5
*Combination Platformer—Unifiner unit.									
Deutsche Erdoel A.G.	1959	0.8					12.3		
Wietz-Celle	1961	0.8					12.3		
	1963	0.8					12.3		
Esso, A.G.	1959	68.0			6.9				
Cologne	1961	68.0			6.9				
	1963	68.0			6.9				
It is reported that by 1965 the capacity will be 150.0 TBD.									
Esso, A.G.	1959	50.4		10.5	7.0		7.6		1.4
Hamburg	1961	50.4		10.5	7.0		7.6		1.4
	1963	60.0		10.5	7.0		7.6		1.4
Esso, A.G.	1959	0							
Karlsruhe, S. Germany	1961	0							
	1963	70.0							
Gelsenberg Benzin, A.G.	1959	66.0		8.8	6.9	0.6	14.0		
Gelsenkerchen-Horst	1961	66.0		8.8	6.9	0.6	14.0		
	1963	66.0		8.8	6.9	0.6	14.0		
Gewerkschaft Erdoel Raff-	1959	18.0	7.9			0.2	1.5		1.7
inerie DEURGA-NERAG	1961	18.4	7.9			0.2	1.5		1.7
Misburg/Hann	1963	26.0	7.9			0.2	1.5		1.7
Gewerkschaft Erdoel Raff-	1959	20.0		8.9	3.0	0.8			
inerie DEURGA-NERAG	1961	50.0		8.9	3.0	0.8			
Lingen/Ems.	1963	50.0		8.9	3.0	0.8			
Gewerkschaft Greiff Berg-	1959	0.5							
bau, Mineraloel, Raff.	1961	0.5							
Dollbergen	1963	0.5							
Kraftstoff Handelsges, mbH	1959	5.0							
Essen	1961	8.0							
	1963	8.0							
Mineraloel und Asphaltwerke	1959	5.0							
A.G.	1961	5.0							
Ostermoor/Holstein	1963	5.0							
Mineralowelwerke Peine	1959	0.4							
Peine	1961	0.4							
	1963	0.4							
Mobil Oil A.G.	1959	28.6		8.0	3.7		5.0		0.7
Bremen	1961	28.6		8.0	3.7		5.0		0.7
	1963	28.6		8.0	3.7		5.0		0.7
Purfina Mineraloel Raffin-	1959	10.0			1.6		1.3		
erie A.G.	1961	54.8			3.3		2.7		
Duisburg	1963	54.8			3.3		2.7		

Name of Company & Location	Year	Crude Capacity	Thermal Capacity	Catalytic Operations: Cracking	Reforming	Poly	Hydrogen Processes	Alky-lation	Lube
Ruhrbau Mineraloelraffin-	1959	6.0							
erie G.m.b.H.	1961	6.0							
Muelheim/Ruhr	1963	6.0							
Ruhrchemie, A.G.	1959	7.5	1.9	3.1	1.9				
Oberhausen-Holten	1961	10.0	0	3.1	1.9				
	1963	10.0	0	3.1	1.9				
Ruhroel, Chemiewerk der	1959	2.4	0.8						
Steinkohlenbergwerke	1961	2.4	0.8						
Bottrop/Rheinland	1963	0	0						
This refinery is now closed down.									
Scholven Chemie, A.G.	1959	40.0		4.7	9.9	0.2	8.8		
Gelsenkirchen-Buer	1961	40.0		4.7	9.9	0.2	8.8		
	1963	44.0		4.7	9.9	0.2	8.8		
Deutsche Shell A.G.	1959	0							
Godorf	1961	40.0		To include cat. reformer and desulferizer					
	1963	80.0							
Eventual capacity might be 120.0-140.0 TBD.									
Deutsche Shell A.G.	1959	56.0		10.7	8.1	1.2	10.8		3.2
Hamburg	1961	56.0		10.7	8.1	1.2	10.8		3.2
	1963	56.0		10.7	8.1	1.2	10.8		3.2
These facilities represent the combined facilities of the Hamburg plant (18.0 TBD) and the new "Hohe Schaar" refinery (38.0) TBD.									
Deutsche Shell A.G.	1959	5.2							1.2
Monheim	1961	5.2							1.2
	1963	5.2							1.2
Union Rheinishe Braun	1959	60.0	15.8		6.1	0.5	8.8		
Kahlen	1961	60.0	15.8		6.1	0.5	8.8		
Wesseling/Cologne	1963	60.0	15.8		6.1	0.5	8.8		
Wintershall, A.G.	1959	2.1							
Salzbergen	1961	2.1							
	1963	2.1							
Zeller und Gmelin	1959	0.2							
Mineral-oelraffinerie	1961	0.2							
Eislingen/Fils	1963	0.2							
The refinery is closed down.									
Unknown	1959	0							
Karlsruhe	1961	0							
	1963	30.0							
Respective participants have only declared their intention to build refinery. No official corporation has been formed.									
GREECE									
"Elbyn" Lubricating Oil	1959	Has applied for a license to construct a 6.0 TBD refinery at Piraeus.							
Refinery Ltd., Piraeus									
Transportation, Trade &	1959	27.0		7.4					
Ref. Co. Ltd.	1961	27.0		7.4					
Aspropyrgos	1963	27.0		7.4					
This company has a ten year lease to operate the refinery for the government.									
GUATEMALA									
Breaux Bridge Ref. Co.	1959	0							
Puerto Barrios In.,	1961	2.8							
Izbal	1963	2.8							
HONDURAS									
15 TBD refinery up for approval by Congress.									
INDIA									
Assam Oil Co. Ltd.	1959	10.0	1.9						0.1
Digboi	1961	10.0	1.9						0.1
	1963	10.0	1.9						0.1
Burmah Shell Refineries	1959	50.0		12.0	6.7				
Bombay	1961	50.0		12.0	6.7				
	1963	50.0		12.0	6.7				
Caltex (India) Ltd.	1959	13.5		7.5		0.8			
Visakhapatam	1961	13.5		7.5		0.8			
	1963	13.5		7.5		0.8			
Indian Refineries Ltd.	1959	0							
Barauni, Bihar	1961	0							
	1963	40.0							
Indian Refineries Ltd.	1959	0							
Gauhati, Assam	1961	0							
	1963	0							

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Name of Company & Location	Year	Crude Capacity	Thermal Capacity	Catalytic Operations: Cracking	Reforming	Poly	Hydrogen Processes	Alky-lation	Lube
Standard Vacuum Ref.	1959	34.0	3.8	8.0		0.3			
Co. of India Ltd.	1961	36.3	3.8	8.0		0.3			
Bombay	1963	36.3	3.8	8.0		0.3			
INDONESIA									
B.P.M.	1959	65.0						5.3	
Balikpapan, Borneo	1961	65.0						5.3	
	1963	65.0						5.3	
B.P.M.	1959	110.0	25.0			0.4			
Pladju S. Sumatra	1961	110.0	25.0			0.4			
	1963	110.0	25.0			0.4			
B.P.M.	1959	4.6							
Tjepu, Cen. Java	1961	4.6							
	1963	4.6							
B.P.M.	1959	3.2							
Wonokromo, E. Java	1961	3.2							
	1963	3.2							
Indonesian Gov't.	1959	2.0							
Pangkalan, Brandan,	1961	2.0							
N. Sumatra	1963	2.0							
Standard Vacuum Pet. Mij	1959	75.0	34.0	10.0		1.2		0.8	
Sungei Gerong,	1961	75.0	34.0	10.0		1.2		0.8	
S. Sumatra	1963	75.0	34.0	10.0		1.2		0.8	
IRAN									
Iranian Oil Expl. & Prod.	1959	0.6							
Field Distillation Units	1961	0.6							
	1963	0.6							
Iranian Oil Expl. & Prod.	1959	18.0							
Mazjid-I-Saliman	1961	18.0							
	1963	18.0							
Iranian Oil Ref. Co.	1959	462.6	74.3	27.0		1.3	1.3	9.9	0.4
Abadan	1961	462.6	74.3	27.0		1.3	1.3	9.9	0.4
	1963	462.6	74.3	27.0		1.3	1.3	9.9	0.4
National Iranian Oil Co.	1959	4.0							
Kermanshah	1961	10.0							
	1963	10.0							
IRAQ									
Gov't. Oil Refineries Adm.	1959	35.1	16.7		1.5				0.5
Baghdad (Dourah)	1961	43.2	16.7		4.5				0.5
	1963	43.2	16.7		4.5				0.5
Gov't. Oil Refineries Adm.	1959	2.0							
Qaiyarah	1961	7.5							
	1963	7.5							
Iraq Pet. Co.	1959	6.5							
Hadi Tha (K3)	1961	6.5							
	1963	6.5							
Iraq Pet. Co.	1959	2.2							
Kirkuk (K-1)	1961	2.2							
	1963	2.2							
Khanaquin Oil Co.	1959	9.0							
Alwand	1961	9.0							
	1963	9.0							
Khanaquin Oil Co.	1959	3.9							
Barsah (Muftiyah)	1961	3.9							
	1963	3.9							
IRELAND									
Irish Refining Co. Ltd.	1959	20.0							
Whitegate, Cork	1961	40.0							
	1963	40.0							
ISRAEL									
Paz Oil Co.	1959	84.0	38.0						
Haifa	1961	84.0	38.0						
	1963	84.0	38.0						
ITALY									
Asfalti Nitumi Catramie	1959	0.1							
Derivate	1961	0.1							
Ragusa, Sicily	1963	0.1							
A.G.I.P. Mineraria S.p.a.	1959	6.4		3.0					
Cortemaggiore (nr.	1961	6.4		3.0					
Cremona)	1963	6.4		3.0					
A.G.I.P.	1959	2.5							
Gela (Sicily)	1961	3.3							
	1963	3.3							
Anonima Petrole Italiani	1959	41.0	7.1		6.4				
Falconara (nr. Ancona)	1961	41.0	7.1		6.4				
	1963	41.0	7.1		6.4				
Soc. per Azionitecnico-	1959	31.0	3.0	6.3	5.0	1.4	5.0		0.9
Industriale	1961	31.0	3.0	6.3	5.0	1.4	5.0		0.9
Trieste	1963	31.0	3.0	6.3	5.0	1.4	5.0		0.9
Condor S.p.a.	1959	54.0		11.7	7.3		6.0		
Rho (nr. Milan)	1961	54.0		11.7	7.3		6.0		
	1963	54.0		11.7	7.3		6.0		
Delle Piane	1959	1.2			0.4				
Genoa, San Quirico	1961	1.2			0.4				
	1963	1.2			0.4				
Distilleria Italiana Catrami	1959	2.7	0.5		0.4				
Massa (nr. Carrara)	1961	2.7	0.5		0.4				
	1963	2.7	0.5		0.4				
Esso Standard Italiana	1959	5.2			1.0				0.5
Trieste	1961	5.2			1.0				0.5
	1963	5.2			1.0				0.5
Garrone	1959	35.0			5.6		2.0		
Genoa, San Quinico	1961	35.0			5.6		2.0		
	1963	35.0			5.6		2.0		
Getty Oil Italiana	1959	30.0			3.0				
Gaeta (Compania)	1961	30.0			3.0				
	1963	30.0			3.0				
Formerly Soc. Golfo Industria Petrolifera.									
Industrie Chemiche Italiane	1959	21.0	5.4		2.5				
del Petroleo (ICIP)	1961	21.0	5.4		2.5				
Mantova	1963	21.0	5.4		2.5				
I.L.S.E.A.	1959	2.8			0.6				
Como	1961	2.8			0.6				
	1963	2.8			0.6				
Soc. Per Industria Italiana	1959	40.0	3.0		6.7				
del Petroleo S.p.a.	1961	40.0	3.0		6.7				
La Spezia	1963	40.0	3.0		6.7				
* Planned 10.0 TBD desulfurization unit. Completion date unknown.									
Industria Piemontese	1959	2.6			1.1				
Lavorazione Olii Minerali	1961	10.6			1.1				
Genoa	1963	10.6			1.1				
Industria Raffinazione	1959	39.0	8.0		2.0	1.6			0.3
Olii Minerali	1961	39.0	8.0		2.0	1.6			0.3
Porto Marghera (Venice)	1963	39.0	8.0		2.0	1.6			0.3
Industrie Siciliane	1959	9.0			1.4				
Lavorazione Olii Minerali	1961	9.0			1.4				
Palermo, Sicily	1963	9.0			1.4				
Raffineria di Petroleo	1959	26.0	2.6	0.8	0.9				
"Italia"	1961	26.0	2.6	0.8	0.9				
Cremona	1963	26.0	2.6	0.8	0.9				
Lombarda Petroli S.A.	1959	5.4	0.8						
Villasanta (nr. Monza	1961	5.4	0.8						
& Milan)	1963	5.4	0.8						
Mobil Oil Italiana	1959	85.0	7.1	13.5	10.0	0.9	10.0		2.7
Naples	1961	85.0	7.1	13.5	10.0	0.9	10.0		2.7
	1963	85.0	7.1	13.5	10.0	0.9	10.0		2.7
Montecatini	1959	4.0							
Ferrara	1961	4.0							
	1963	4.0							
Raffineria NILO S.p.a.	1959	7.0			0.9				
Milan	1961	7.0			0.9				
	1963	7.0			0.9				
Petroli D'Italia S.p.a.	1959	5.4	2.8						
Fiorenzuola D'Arda (be-	1961	5.4	2.8						
tween Parma & Piacenza)	1963	5.4	2.8						

(Continued)

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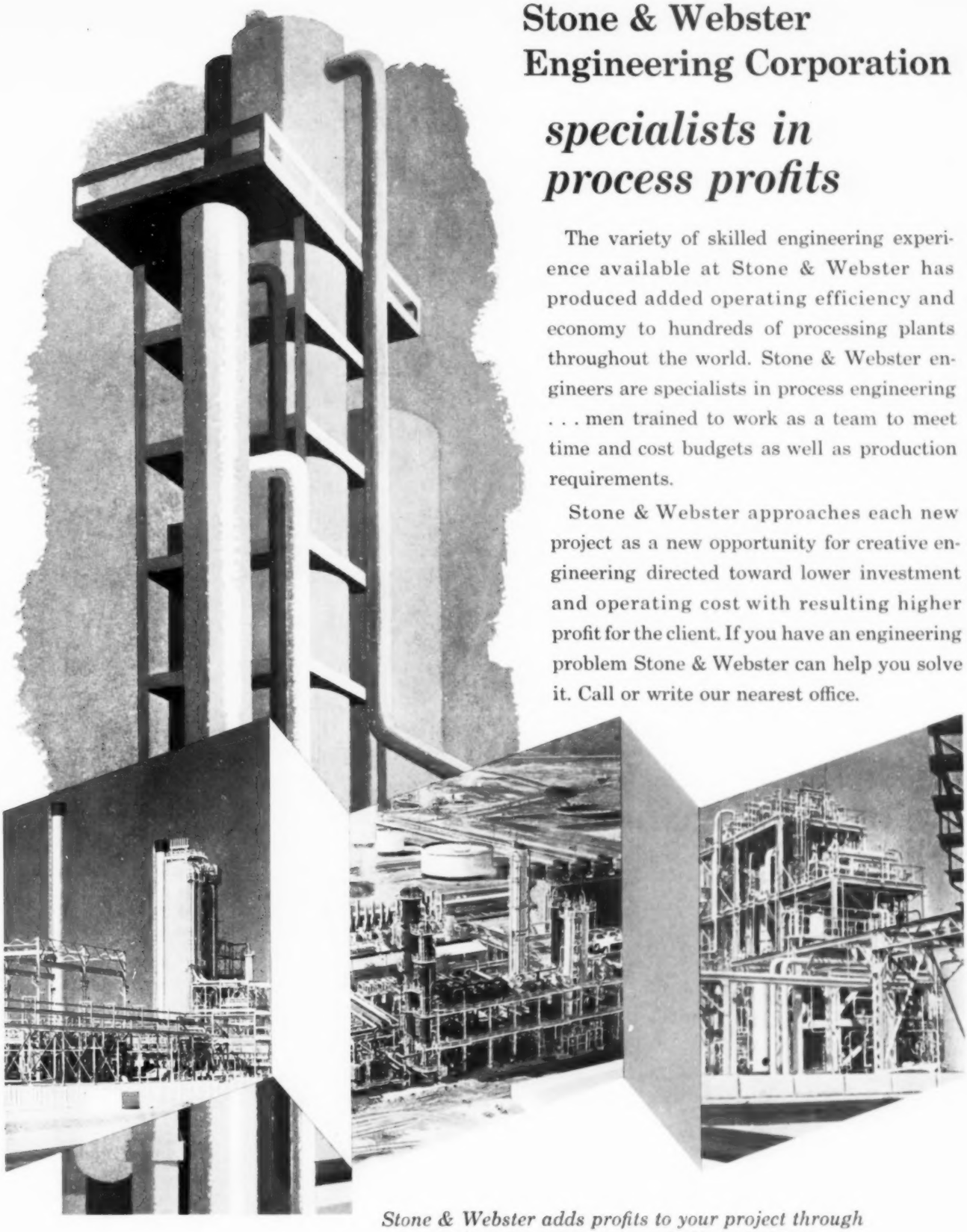

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Name of Company & Location	Year	Crude Capacity	Thermal Capacity	Catalytic Operations: Cracking	Reforming	Poly	Hydrogen Processes	Alky-lation	Lube
Purfina Italiana	1959	4.4	0.7						
Florence	1961	4.4	0.7						
	1963	4.4	0.7						
Purfina Italiana	1959	12.6		1.2	1.0				
Genoa	1961	12.6		1.2	1.0				
	1963	12.6		1.2	1.0				
Purfina Italiana	1959	9.8			0.9				0.2
Milan	1961	9.8			0.9				0.2
	1963	9.8			0.9				0.2
Raffineria Siciliana Olii	1959	100.0	14.0		7.3	1.7	*		
Minerali	1961	100.0	14.0		7.3	1.7			
Augusta (Sicily)	1963	100.0	14.0		7.3	1.7			
* Plan for 8.0 TBD desulfurization unit. Completion date unknown.									
Raffineria Olii Lubrificanti	1959	1.5							0.4
Viguzzolo	1961	1.5							0.4
	1963	1.5							0.4
San Quirico	1959	4.4			1.5				
Genoa San Quirico	1961	4.4			1.5				
	1963	4.4			1.5				
Soc. Anonima Raffinazione	1959	48.0	7.0	1.5	4.3		7.0		
Ravenna	1961	48.0	7.0	1.5	4.3		7.0		
	1963	48.0	7.0	1.5	4.3		7.0		
Soc. per Azioni Raffineria	1959	20.0	4.3	2.4	3.5	1.7			
Padana Olii Minerali	1961	20.0	4.3	2.4	3.5	1.7			
Trecate (nr. Novara)	1963	20.0	4.3	2.4	3.5	1.7			
S. I. R. O. M.	1959	1.3							
Monza (nr. Milan)	1961	1.3							
	1963	1.3							
Soc. Mediterranea Raffineria	1959								
Siciliana Petroli	1961								
Milazzo (Sicily)	1963								
Authorization decree granted for 50 TBD plant. Ownership & completion date not yet announced.									
Soc. Raffineria Roma	1959	0		0					
Fregene (nr. Rome)	1961	26.5		2.5					
	1963	26.5		2.5					
This plant placeses Purfinas' 12.6 TBD refinery at Rome which is to be dismantled and rebuilt at Fegene. Date of completion is estimated.									
Soc. Petrolifera Italiana	1959	2.0			0.9				
Fornova (nr. Parka)	1961	2.0			0.9				
	1963	2.0			0.9				
Stanic	1959	49.0	2.1		7.3		7.2		
Bari	1961	75.0	2.1		7.3		7.2		
	1963	75.0	2.1		7.3		7.2		
Stanic	1959	52.0	8.1		9.0		6.0		2.1
Leghorn (Livorno)	1961	52.0	8.1		9.0		6.0		2.1
	1963	52.0	8.1		9.0		6.0		2.1
S.T. O. I.	1959	17.1	1.0		2.5				
Florence	1961	17.1	1.0		2.5				
	1963	17.1	1.0		2.5				
ENI's annual report for 1957 indicated plans for expansion to 30.0 TBD.									
Volpato	1959	1.8							
Milan	1961	1.8							
	1963	1.8							
JAMAICA									
Jamaica Oil & Chemical Co.	1959	0							
Nr. Kingston	1961	15.0							
	1963	15.0							
JAPAN									
Asia Oil	1959	10.0			1.5		1.4		0.3
Yokohama, Tokyo Bay	1961	10.0			1.5		1.4		0.3
	1963	10.0			1.5		1.4		0.3
Daikyo Oil	1959	25.0	0.2	3.5	3.0				1.8
Yokkaichi, E. Coast	1961	25.0	0.2	3.5	3.0				1.8
Honshu	1963	25.0	0.2	3.5	3.0				1.8
General Bussan	1959	0			0				
Kawasaki, Tokyo Bay	1961	0			0				
	1963	35.0			3.8				

Name of Company & Location	Year	Crude Capacity	Thermal Capacity	Catalytic Operations: Cracking	Reforming	Poly	Hydro Processes	lation	Lube
Idemitsu Kosan	1959	0		0	0				
Kawasaki, Tokyo Bay	1961	0		0	0				
	1963	50.0		15.0	5.0				
Idemitsu Kosan	1959	41.5		7.0	3.0		2.7		
Tokuyama, Inland Sea	1961	41.5		7.0	3.0		2.7		
	1963	41.5		7.0	3.0		2.7		
Koa Oil	1959	32.1	2.5	0	3.0				1.0
Marifu (Iwakuni)	1961	32.1	4.5	5.5	3.0				1.0
Inland Sea	1963	32.1	4.5	5.5	3.0				1.0
Kita Nippon Oil	1959	10.8			1.5				
Hakodate, Hokkaido	1961	10.8			1.5				
	1963	10.8			1.5				
Maruzen	1959	0							
Goi (Chiba) Tokyo Bay	1961	18.0							
	1963	18.0							
Expansion to 60-100 TBD by 1965-1967 planned.									
Maruzen	1959	9.0			3.0				
Matzuyama, Shikoku	1961	9.0			3.0				
	1963	9.0			3.0				
Maruzen	1959	33.5		3.0					1.1
Shimotsu, Inland Sea	1961	33.5		3.0					1.1
	1963	33.5		3.0					1.1
Mitsubishi Oil Co.	1959	55.6	2.7		3.0		12.5		0.8
Kawasaki, Tokyo Bay	1961	55.6	2.7		3.0		12.5		0.8
	1963	55.6	2.7		3.0		12.5		0.8
Mitsubishi Oil Co.	1959	0							
Coast Honshu	1961	40.0							
East	1963	40.0							
Nippon Minning	1959	13.7			1.0				0.4
Funakawa	1961	13.7			1.0				0.4
W. Coast Honshu	1963	13.7			1.0				0.4
Nippon Oil	1959	3.4	1.0						0.2
Akita	1961	3.4	1.0						0.2
W. Coast Honshu	1963	3.4	1.0						0.2
Nippon Oil	1959	2.4							0.2
Kahiwazaki, W. Coast	1961	2.4							0.2
W. Coast Honshu	1963	2.4							0.2
Nippon Oil	1959	5.9			1.6				0.9
Niigata	1961	5.9			1.6				0.9
W. Coast Honshu	1963	5.9			1.6				0.9
Nippon Paraffin Co.	1959	1.9							
Tokuyama, Inland Sea	1961	1.9							
	1963	1.9							
Nippon Pet. Ref. Co.	1959	23.0			1.5				1.6
Kudamatsu, Inland Sea	1961	23.0			1.5				1.6
	1963	23.0			1.5				1.6
Nippon Pet. Ref. Co.	1959	10.0							
Muroran	1961	10.0							
	1963	10.0							
Nippon Pet. Ref. Co.	1959	41.0		5.1	3.0		2.7		1.4
Yokohama, Tokyo Bay	1961	62.0		10.0	3.0		2.7		1.4
	1963	62.0		10.0	3.0		2.7		1.4
Rekisei Mineral Oil	1959	1.1							
Niigata	1961	1.1							
W. Coast Honshu	1963	1.1							
Showa Oil	1959	2.7							0.4
Hirasawa	1961	2.7							0.4
W. Coast Honshu	1963	2.7							0.4
Showa Oil	1959	25.0							1.3
Kawasaki, Tokoyo Bay	1961	25.0							1.3
	1963	25.0							1.3
Showa Oil	1959	9.0							0.4
Niigata	1961	9.0							0.4
W. Coast Honshu	1963	9.0							0.4
Showa Yokkaichi Oil	1959	36.9		12.0					
Yokkaichi	1961	36.9		12.0					
E. Coast Honshu	1963	36.9		12.0					

(Continued)

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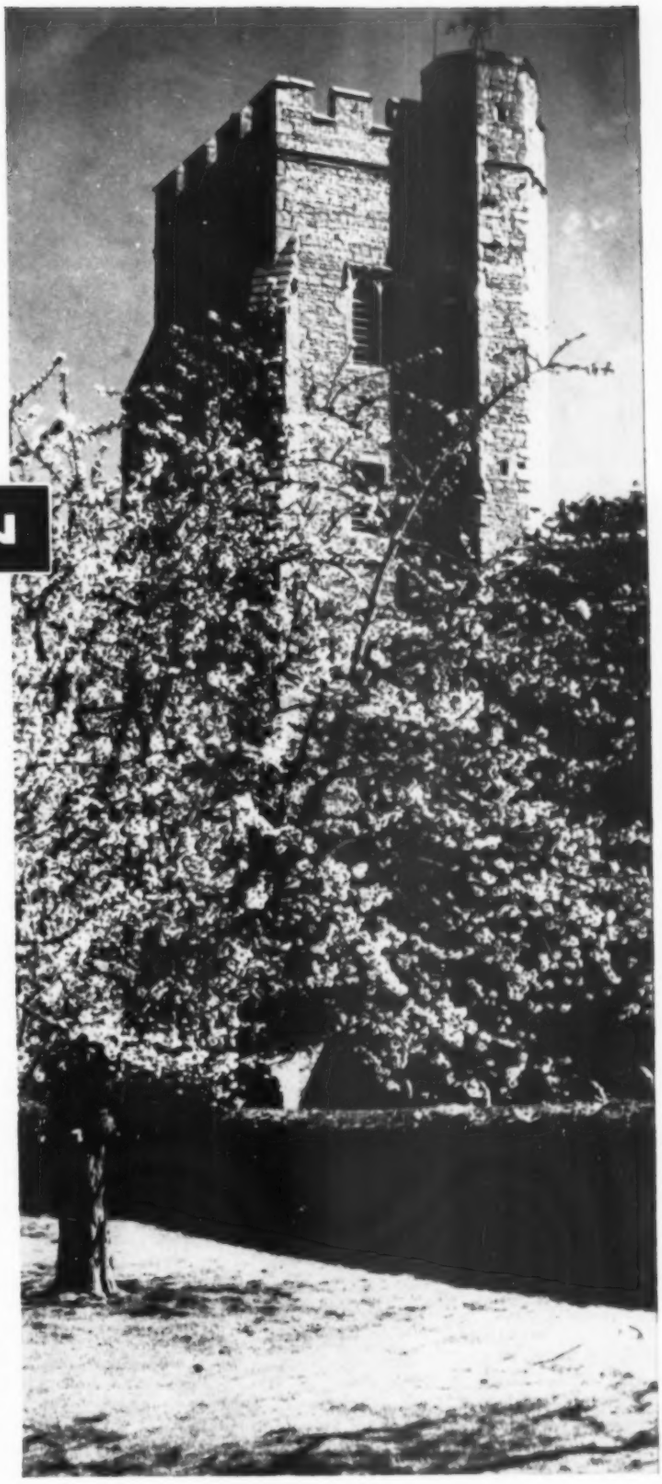
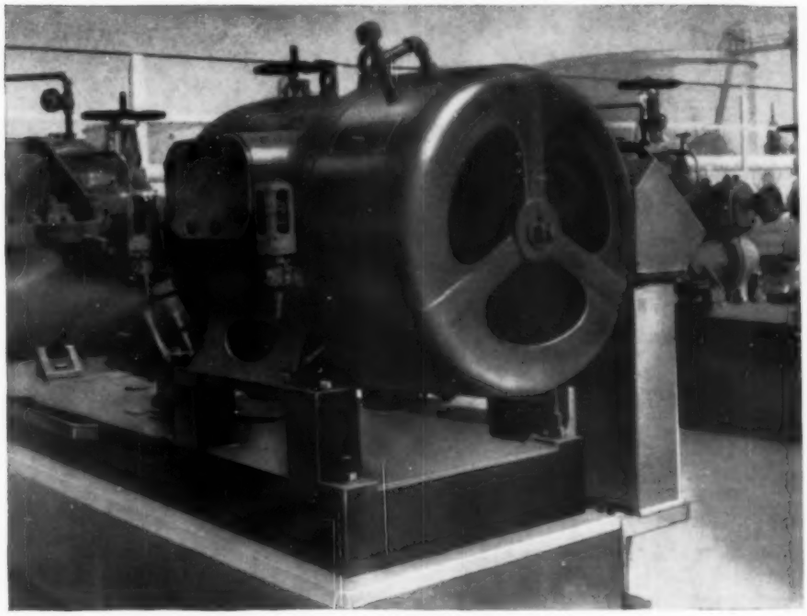


Name of Company & Location	Year	Crude Capacity	Thermal Capacity	Catalytic Operations: Cracking	Reforming	Poly	Hydrogen Processes	Alky-lation	Lube
Taiyo Oil	1959	4.5							0.4
Kameoka Shikoku	1961	4.5							0.4
	1963	4.5							0.4
Toa Neuryo Kogyo	1959	40.0			4.6		4.2		0.6
Shimizu	1961	40.0			4.6		4.2		0.6
E. Coast Honshu	1963	40.0			4.6		4.2		0.6
Toa Nenryo Kogyo	1959	50.0	3.2	18.0	4.2			1.5	1.6
Wakayama, Inland Sea	1961	50.0	3.2	18.0	4.2			1.5	1.6
	1963	50.0	3.2	18.0	4.2			1.5	1.6
Toa Oil	1959	10.0			0				
Kawasaki, Tokyo Bay	1961	10.0			9.0				
	1963	10.0			9.0				
JORDAN									
Jordanian Ref. Works Co.	1959	0.6							
Amman	1961	6.6							
	1963	6.6							
KUWAIT									
American Independent	1959	30.0							
Oil Co.	1961	30.0							
Mina Abdullah	1963	30.0							
Kuwait Oil Co. Ltd.	1959	171.0			3.8				
Mina-al-Ahmadi	1961	171.0			3.8				
	1963	171.0			3.8				
LEBANON									
Iraq Pet. Co.	1959	11.2			0				
Tripoli	1961	11.2			3.1				
	1963	11.2			3.1				
Mediterranean Ref. Co.	1959	12.0							
Sidon	1961	12.0							
	1963	12.0							
MEXICO									
Petroleos Mexicanos	1959	40.0							
Arbol Grande	1961	40.0							
Tampico	1963	40.0							
Petroleos Mexicanos	1959	100,0	14.5	14.5		0.8	39.0	1.2	
Atzcapotzalco,	1961	100.0	14.5	14.5		0.8	39.0	1.2	
Mexico City	1963	100.0	14.5	14.5		0.8	39.0	1.2	
Petroleos Mexicanos	1959	100.0	5.5	0	12.0	1.7		0	
Ciudad Madero	1961	150.0	5.5	20.0	32.0	2.5		1.5	
Tampico	1963	150.0	5.5	20.0	32.0	2.5		1.5	
Petroleos Mexicanos	1959	0							
Guaymes	1961	15.0							
N.W. Coast	1963	30.0							
Petroleos Mexicanos	1959	14.0	6.0						
Mata Redonda	1961	34.0	6.0						
Tampico	1963	34.0	6.0						
Petroleos Mexicanos	1959	50.0	21.5			1.4			0.8
Minatitlan, Isthmus	1961	50.0	21.5			1.4			0.8
	1963	50.0	21.5			1.4			0.8
Petroleos Mexicanos	1959	7.0							
Roza Rica	1961	7.0							
	1963	7.0							
Petroleos Mexicanos	1959	10.0	4.2						
Reynosa	1961	20.0	4.2						
	1963	20.0	4.2						
Petroleos Mexicanos	1959	40.0	5.0	10.0			9.0		2.4
Salamanca	1961	70.0	5.0	10.0			9.0		2.4
	1963	70.0	5.0	10.0			9.0		2.4
MOROCCO									
Soc. Cherifienne des	1959	2.4		3.5					
Petroles	1961	2.4		3.5					
Petitjean	1963	2.4		3.5					
NETHERLANDS									
N.V. de Bataafsche Pet.	1959	300.0	30.0	66.0	12.7	4.7	21.8	2.5	2.9
Mij.	1961	300.0	30.0	66.0	12.7	4.7	21.8	2.5	2.9
Rotterdam	1963	300.0	30.0	66.0	12.7	4.7	21.8	2.5	2.9
Caltex Petroleum Mij.	1959	56.0	14.4		7.0	2.4	4.2		
Rotterdam	1961	100.0	16.7		14.2	2.4	4.2		
	1963	100.0	16.7		14.2	2.4	4.2		

Name of Company & Location	Year	Crude Capacity	Thermal Capacity	Catalytic Operations: Cracking	Reforming	Poly	Hydrogen Processes	Alky-lation	Lube
Esso Nederland N.V.	1959	0							
Rotterdam	1961	95.0			*	*			
	1963	95.0			*	*			
* Capacity unavailable									
NETHERLAND ANTILLES									
Lago Oil & Trans. Co.	1959	440.0	321.0	43.0				5.0	
Aruba	1961	440.0	321.0	43.0				5.0	
	1963	440.0	321.0	43.0				5.0	
N.Y. Curacaosche Pet.	1959	210.0	105.0	35.0				4.5	6.6
Industrie Mij.	1961	210.0	105.0	35.0				4.5	6.6
Curacao	1963	210.0	105.0	35.0				4.5	6.6
NEUTRAL ZONE									
Getty Oil Co.	1959	50.0							
Mina Saud	1961	50.0							
	1963	50.0							
NEW ZEALAND									
Shell is reported to have to build a 40,000-bbl. refinery but completion date is not available.									
NICARAGUA									
Plan to build a 10 TBD refinery. No location mentioned									
NORWAY									
Aksjeselskapet Norske Esso	1959	2.0							0.3
Vallo (Tansberg)	1961	2.0							0.3
	1963	2.0							0.3
British Pet.	1959	0							
Oslo	1961	40.0*							
	1963	40.0							
* Capacity could range between 40 TBD & 80 TBD									
A/S Esso Raffineriet Norge	1959	0							
Oslo	1961	40.0							
	1963	40.0							
PAKISTAN									
Attock Oil Co. Ltd.	1959	5.0							
Rawalpindi	1961	5.0							
	1963	5.0							
Consortuim	1959	0							
Karachi	1961	0							
	1963	32.0							
PANAMA									
Refineria Petroquimica	1959	0							
Panama SA	1961	60.0							
Portobelo Harbor	1963	60.0							
PERU									
Cia de Petroleo Ganzo	1959	1.0							
Azul	1961	1.0							
Agua Caliente	1963	1.0							
E. P. F.	1959	1.5							
Iquitas	1961	1.5							
	1963	1.5							
International Pet. Co.	1959	45.0	14.5						0.5
Talara	1961	45.0	14.5						0.5
	1963	45.0	14.5						0.5
PHILIPPINE ISLANDS									
Caltex (Philippines)	1959	20.0		5.4		1.5			
Batangas	1961	23.0		5.4		1.5			
	1963	24.0		5.4		1.5			
Philippine Management	1959	0							
Investment Consultants	1961	10.0							
Unknown	1963	10.0							
Shell	1959	0							
Unknown	1961	0							
	1963	29.0							
Standard Vacuum	1959	0		0					
Manila	1961	27.0		0					
	1963	28.0		6.0					
PORTUGAL									
S. A. C. O. R.	1959	21.6		9.5		1.3			0.2
Cabu Ruivo, Lisbon	1961	27.0		9.5		1.3			0.2
	1963	27.0		9.5		1.3			0.2
PUERTO RICO									
Carribbean Ref. Co.	1959	18.0		6.0		0.5			
San Juan	1961	23.0		6.0		0.5			
	1963	23.0		6.0		0.5			

(Continued)

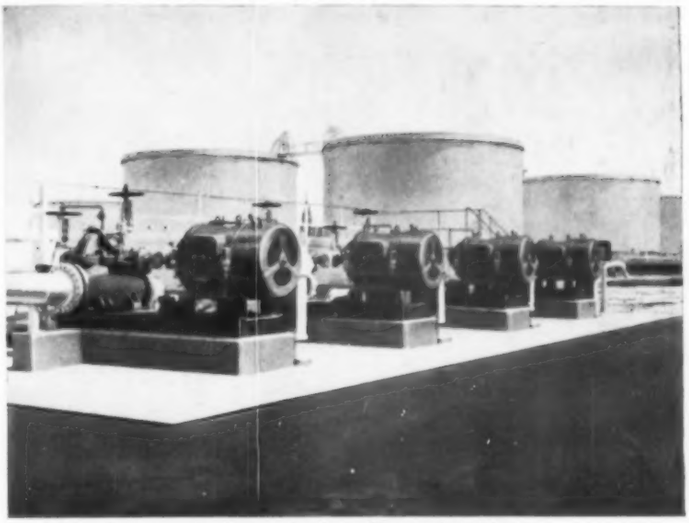
Flameproof Motors for the Oil Industry



A. Metrovick 250 h. p. 1480 r. p. m. Flameproof Squirrel Cage Motor—one of four supplied to the Kwinana Oil Refinery

Oil wells and refineries throughout the world rely on A.E.I. equipment. Their experience of motors and their proper application covers all drives in the oil industry, from drilling to refining. Some of the refineries using these motors are the Grangemouth Petroleum Refinery, Ltd., Shell Stanlow Refinery, Esso Refinery, Fawley, Texaco (Trinidad), Point-a-Pierre Refinery, B.W.I., and (illustrated) British Petroleum Company's Refinery at Kwinana, Australia.

Special arrangements were put in hand to guarantee that these motors were delivered to meet site requirements.



This photograph shows the four Metrovick Flameproof Motors driving kerosene pumps at Tank Farm Pumping Station No. 3. These motors are fitted with constant-level oil lubricators.

ASSOCIATED ELECTRICAL INDUSTRIES LIMITED

MOTOR & CONTROL GEAR DIVISION RUGBY & MANCHESTER, ENGLAND

INCORPORATING THE MOTOR & CONTROL GEAR INTERESTS OF BTH & M-V

JX/0501

Name of Company & Location	Year	Crude Capacity	Thermal Capacity	Catalytic Operations: Cracking	Reforming	Poly	Processes	Alky-lation	Lube
Commonwealth Ref. Co.	1959	65.0	10.0	24.8	7.4	1.2		2.8	
Ponce	1961	75.0	20.0	24.8	7.4	1.2		2.8	
	1963	75.0	20.0	24.8	7.4	1.2		2.8	
QATAR									
Qatar Pet. Co.	1959	0.6							
Umon Said	1961	0.6							
	1963	0.6							
Plan for expanding crude distillation facilities to 2.4 TBD is scheduled for review in 1961.									
SAUDI ARABIA									
Arabian American Oil Co.	1959	219.0	25.0		14.0	1.0	15.0	0.7	
Ras Tanura	1961	219.0	25.0		14.0	1.0	15.0	1.2	
	1963	219.0	25.0		14.0	1.0	15.0	1.2	
SPAIN									
Refineria de Petroleos	1959	80.0	9.0		11.0	1.6			0.5
de Escombreras S.A.	1961	90.0	9.0		11.0	1.6			0.5
Escombreras	1963	90.0	9.0		11.0	1.6			0.5
Compania Espanola de	1959	59.6	5.2		4.6		0		0.5
Petroleos, S.A.	1961	59.6	5.2		4.6		4.6		0.5
Santa Cruz de Tenerife	1963	59.6	5.2		4.6		4.6		0.5
SWEDEN									
A. B. Nymas-Petroleum	1959	2.6							
Gothenburg	1961	2.6							
	1963	2.6							
A. B. Nymas-Petroleum	1959	1.7							
Malmo	1961	1.7							
	1963	1.7							
A. B. Nymas-Petroleum	1959	12.6	2.6		6.2	0.2	*		
Nynashem	1961	31.5	2.6		6.2	0.2			
	1963	31.5	2.6		6.2	0.2			
* Unit to be modernized and Expanded. Current capacity unavailable.									
Koppartrans Oljeaktiebolag	1959	36.3	4.0		5.0		0		
Sharvik	1961	36.3	4.0		5.0		7.2		
	1963	36.3	4.0		5.0		7.2		
SYRIA									
Government	1959	10.0							
Homs	1961	20.0							
	1963	20.0							
TAIWAN									
Chinese Pet. Corp.	1959	21.0	3.8	10.2	2.5				0.6
Kaohsiung	1961	21.0	3.8	10.2	2.5				1.0
	1963	21.0	3.8	10.2	2.5				1.0
THAILAND									
Thai Gov't.	1959	1.0							
Farng	1961	1.0							
	1963	1.0							
Unknown*	1959	0							
Bangkok	1961	0							
	1963	5.0							
* Maruzen Oil Co. or Niikata and Fuji Car, or other Japanese interests may build this plant. Alternate plans call for 15 TBD.									
TRINIDAD									
Shell Trinidad Ltd.	1959	47.0							
Point Fortin	1961	64.0							
	1963	64.0							
The Texas Co.	1959	5.0							
La Brea	1961	5.0							
	1963	5.0							
The Texas Co.	1959	100.0	47.5	25.0	8.0	4.7	10.0	1.8	
Point-A-Pierre*	1961	100.0	47.5	25.0	8.0	4.7	10.0	1.8	
	1963	100.0	47.5	25.0	8.0	4.7	10.0	1.8	
*Plans have been approved to double capacity of this plant. No starting or completion dates mentioned.									
TURKEY									
Anadolee Tasfiyehanesi, S.A.	1959	0			0		0		
Mersin	1961	0			0		0		
	1963	61.7					7.2		*7.3
*Kerosine desulfurization unit. The refinery will also include a 16.0 TBD naphtha hydrodesulfurization unit.									
Marmara Pet. & Ref. Works*	1959								
Istanbul	1961								
	1963								
*Have applied to build a 14.4 TBD refinery near Istanbul.									

Name of Company & Location	Year	Crude Capacity	Thermal Capacity	Catalytic Operations: Cracking	Reforming	Poly	Hydrogen Processes	Alky-lation	Lube
Turkish Pet. Corp.	1959	6.3		2.0					
Batman	1961	6.3		2.0					
	1963	13.0		6.7					
Turkish American Oil Co.*	1959								
Istanbul	1961								
	1963								
*Plans to construct a 15.0 TBD refinery near Istanbul, including a 2.2 TBD vis breaker, a 4.4 TBD catalytic cracker and a 0.4 polymerization unit.									
UNITED KINGDOM									
Berry Wiggins & Co. Ltd.	1959	2.0							0.3
Kingsmouth nr. Rochester	1961	2.0							0.3
Kent	1963	2.0							0.3
Berry Wiggins & Co. Ltd.	1959	2.0							0.2
Weaste, Lanes	1961	2.0							0.2
	1963	2.0							0.2
Wm. Briggs & Sons Ltd.	1959	0.7							
Dundee, Scotland	1961	0.7							
	1963	0.7							
British Pet. Ref. (Kent) Ltd.	1959	142.0	10.8	11.3	14.4		18.0	2.0	2.5
Isle of Grain (Kent)	1961	180.0	10.8	11.3	14.4		18.0	2.0	2.5
	1963	180.0	10.8	11.3	14.4		18.0	2.0	2.5
B. P. Grangemouth Ltd.	1959	44.0		11.9		0.7	0.5		
Grangemouth, Scotland	1961	65.0		11.9		0.7	0.5		
	1963	65.0		11.9		0.7	0.5		
B. P. (Llandarcy) Ltd.	1959	60.0		11.3	5.4		3.2		1.8
Llandarcy, Wales	1961	63.0		11.3	5.4		3.2		1.8
	1963	63.0		11.3	5.4		3.2		1.8
Scottish Oils Ltd.	1959	3.2	1.4	2.8					
Pumpherston, Scotland	1961	3.2	1.4	2.8					
	1963	3.2	1.4	2.8					
Esso Pet. Co., Ltd.	1959	0			0		0		
Milford Haven, Wales	1961	90.0			14.9		14.9		
	1963	90.0			14.9		14.9		
Esso Pet. Co. Ltd.	1959	210.0	5.5	43.5	37.6	8.0	17.1		2.9
Fawley, Hampshire	1961	210.0	5.5	43.5	32.2	8.0	17.1		4.2
	1963	231.0	5.5	43.5	32.2	8.0	17.1		4.2
Lobitos Oilfields Ltd.	1959	4.2	0.8		0.7				0.6
Ellesmere Port, Cheshire	1961	4.2	0.8		0.7				0.6
	1963	4.2	0.8		0.7				0.6
Manchester Oil Refinery Ltd.	1959	3.5							1.8
Trafford Park, Manchester	1961	3.5							1.8
	1963	3.5							1.8
Mobil Oil Co. Ltd.	1959	29.6		9.5	5.4		*		3.0
Coryton, Essex	1961	35.0		9.5	5.4				3.0
	1963	35.0		9.5	5.4				3.0
*An BTBD desulfurization unit is planned.									
Regent Oil Co. Ltd.	1959	0							
Unknown	1961	25.0							
	1963	50.0							
Shell Ref. & Mktg. Co. Ltd.	1959	160.0	13.0		6.7		0		2.4
Shellhaven, Essex	1961	160.0	13.0		6.7		16.0		2.4
	1963	160.0	13.0		6.7		16.0		2.4
Shell Ref. & Mktg. Co. Ltd.	1959	105.0	13.0	35.0	10.0	2.0	4.4		3.9
Stanlow, Cheshire	1961	105.0	13.0	33.0	10.0	2.0	4.4		3.9
	1963	105.0	13.0	33.0	10.0	2.0	4.4		3.9
Shell Ref. & Mktg. Co. Ltd.	1959	36.0	10.0						
Heysham, Lancashire	1961	36.0	10.0						
	1963	36.0	10.0						
Starhaven Refineries Ltd.	1959	3.2							
Ardrossan	1961	3.2							
	1963	3.2							
URUGUAY									
A.N.C.A.P.	1959	28.0	2.2	0	3.0				
	1961	56.0	2.2	5.0	3.0				
	1963	56.0	2.2	5.0	3.0				
VENEZUELA									
Cia. Shell de Venezuela	1959	45.0							
San Lorenzo	1961	45.0							
	1963	45.0							

(Continued)

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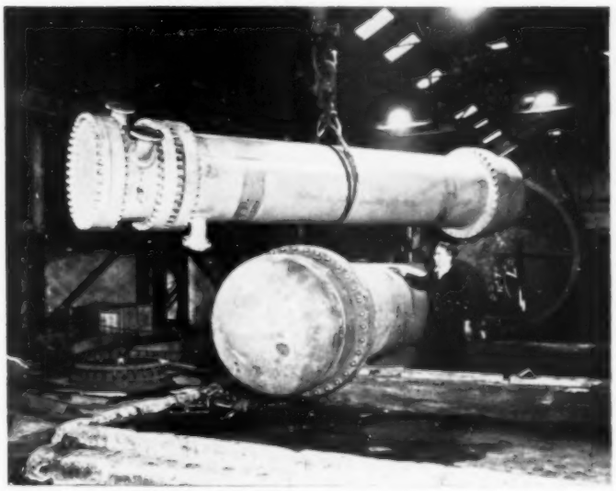

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Name of Company & Location	Year	Crude Capacity	Thermal Capacity	Catalytic Operations: Cracking	Reforming	Poly	Hydrogen Processes	Alky-lation	Lube
Cia. Shell de Venezuela	1959	220.0	33.0	33.0		2.0		2.3	3.3
Punta Cardon	1961	220.0	33.0	33.0		2.0		2.3	3.3
	1963	220.0	33.0	33.0		2.0		2.3	3.3
Creole Petroleum Corp.	1959	328.0			10.2		17.0		0.7
Amuay Bay	1961	328.0			10.2		17.0		0.7
	1963	328.0			10.2		17.0		0.7
Creole Petroleum Corp.	1959	60.0	42.0						
Caripito	1961	60.0	42.0						
	1963	60.0	42.0						
Petrochemical Institute	1959	3.0							
Moron	1961	3.0							
	1963	3.0							
Phillips Petroleum Co.	1959	6.7							
San Roque	1961	6.7							
	1963	6.7							
Richmond Expl. Co.	1959	50.0							
Bajo Grande	1961	53.0							
	1963	53.0							
Sinclair Oil & Ref. Co.	1959	35.0	12.0						
Puerto la Cruz	1961	35.0	12.0						
	1963	35.0	12.0						
Socony Mobil Oil de	1959	0			0				
Venezuela	1961	40.0			5.5				
Puerto Cabello	1963	40.0			5.5				
Texas Petroleum Co.	1959	10.0							
Tucupita	1961	10.0							
	1963	10.0							
Venezuelan Gulf Ref. Co.	1959	60.0	26.5	8.5					
Puerto la Cruz	1961	120.0	26.5	8.5					
	1963	120.0	26.5	8.5					
YUGOSLAVIA									
Government	1959	0		0	0		0		0
Undecided	1961	0		0	0		0		0
	1963	21.9		11.0	3.5		6.3		0.4
Government	1959	6.6	2.4						0.4
Bozanski Brod	1961	13.2	6.4						0.4
	1963	13.2	6.4						0.4
Government	1959	7.3			0				0.4
Rijeka	1961	8.5			2.0				0.8
	1963	8.5			2.0				0.8
Government	1959	8.8		4.0					
Sisak	1961	12.4		4.0					
	1963	12.4		4.0					

END

Review of USA Patents

(continued from page 82)

pagnat and C. Vernet (2,834,716 to British Petroleum Co.) effect the extractive crystallization of mineral oil fractions with urea.

b. *Feed Preparation*—Removal of basic nitrogen compounds from hydrocarbons is the subject of considerable patent literature. The following three patents are typical. J. D. Kemp (2,847,362 to California Research Corp.) employs alcohol extraction and phosphoric acid treatment. J. G. Gatsis (2,848,375 to Universal Oil Products Co.) treats with a solution of boric acid and a polyhydroxy organic compound. F. J. Dykstra in Ethyl Corp.'s 2,862,879 proposes treatment with an ester of metaboric acid, forming a removable precipitate.

The presence of small amounts of acetylenes interferes with many catalytic reactions. J. P. Hogan (2,851,504 to Phillips Petroleum Co.) removes acetylene from unsaturated gases and hydrogen by contact with alkalized iron oxide-chromium oxide catalyst in the presence of water vapor. According to Esso Res. & Eng. Co.'s 2,847,487 (W. N. Kestner, W. C. Kohfeldt and S. B. Eubank) acetylene is separated from butadiene bearing streams by complexing with a cuprous salt solvent solution. Selective hydrogenation of diolefins to monoolefins is discussed in Esso Res. & Eng. Co.'s 2,861,946 (R. W. Sage and C. H. Jones).

A method for removing heavy metals from petroleum stocks by treatment with sulfur is disclosed in S. W. Weller's 2,854,399 (to Houdry Process Corp.) I. W. Mills (2,865,838 to Sun Oil Co.) removes organometallics from hydrocarbons by treatment with solid phosphoric acid catalyst. Purification of a petroleum fraction by treatment with molecular sieve adsorbents is the subject of The Texas Co.'s 2,859,173 (H. V. Hess and E. R. Christensen).

c. *Stabilization*—Liquid phase water washing of selected alkylate fractions is a means of preparing an odor-free naphtha. (2,874,115, G. W. Ayers and W. J. Sandner to The Pure Oil Co.). A method for preparing an oxidation inhibitor from a catalytically cracked residue is discussed in Sun Oil Co.'s 2,846,372 (A. Schneider and A. P. Stuart).

Stabilization of middle oils is the subject of Esso Res. & Eng. Co.'s 2,845,388 (J. F. Black, D. A. Guthrie, G. A. Weissgerber and J. J. Heigl). The oil is blown with oxygen containing gas, while irradiating with gamma rays. F. J. Brooks and C. A. Duval, Jr. (2,868,722 to Socony-Mobil Oil Co.) stabilize fuel oils with respect to color and sedimentation by extracting acidic organic material with aqueous alkali metal hydroxide solutions. J. L. Jezl (2,832,723 to Sun Oil Co.) refines petroleum fractions by partial oxidation and contacting of the oxidized material with an epoxide. P. Y. C. Gee (2,849,301 to Socony-Mobil Oil Co.) reduces clogging tendencies of fuel oils by a soluble ester additive.

Gasoline additives are discussed in a large number of patents. D. A. Hirschler, Jr., G. Irish and J. B. Hinkamp (2,834,662-2,834,664 to Ethyl Corp.) add a gasoline soluble organic strontium compound to gasoline to inhibit combustion chamber deposits. A phosphonitrilic halide additive is proposed in Ethyl Corp.'s 2,833,635 (E. F. Hill and D. O. DePree). R. G. Lyben (2,849,302-2,849,304 to Ethyl Corp.) reveals 2,3-dibromo- 2,3-dimethylbutane as a lead scavenger. A number of Texas Co. patents deal with means to reduce deposit forming tendencies of motor fuels. S. R. Newman, R. Y. Heisler, K. L. Dillett and N. Alpert (2,842,433) propose a polyglycol carbonate and R. Y. Heisler and S. R. Newman (2,844,448-2,844,451) a polyglycol carbonate additive.

A group of Gulf Oil Corp. patents describes antistalling additives. T. L. Cantrell, J. French and P. K. Kuhne (2,863,742; 2,863,744-2,863,747) employ a combination of light lube oil and amine salt of an organic phosphate. In another Gulf patent (2,863,743) J. P. Pellegrini, Jr. and H. I. Thayer inhibit preignition tendency of leaded fuels by addition of an alkyl-phosphoramid. For the same purpose S. M. Darling (2,844,447 to Standard Oil Co., Ohio) employs dialkyl sulfite. Substituted imidazoline causes inhibition of carburetor deposits according to California Research Corp.'s 2,839,371-2,839,373 (H. W. Sigworth, E. G. Lindstrom and M. R. Barusch). C. L. Thomas (2,857,254 to Sun Oil Co.) prevents carburetor icing by adding 0.5-10 vol. % of an olefin oxide to gasoline. F. L. Jonach and J. E. Hickok (2,825,637 to Esso Res. & Eng. Co.) propose an antistalling additive, comprising N-(methylene-carbinol) tetrahydro para oxazine. In another Esso patent (2,838,387) H. W. Rudel employs fluorinated hydrocarbons to reduce engine deposits.

d. *Miscellaneous*—Two Esso Res. & Eng. Co. patents deal with the removal of carcinogenic compounds from high boiling catalytically cracked fractions. In 2,833,834 J. Rehner and L. T. Eby alkylate high boiling aromatics with a C_5 olefin, using aluminum chloride catalyst. In 2,848,379 the same inventors treat the high boiling fraction with activated carbon.

W. B. Cleveland

Dr. A. G. Oblad

WILLIAM B. CLEVELAND has been elected a director of Standard-Vacuum Oil Co. He will assume his new duties in mid-August.

Dr. ALEX G. OBLAD, vice president in charge of research and development, The M. W. Kellogg Co., New York, was awarded an honorary Doctor of Science degree by Purdue University, Lafayette, Ind. in recognition of his accomplishments as a scientific director of research, author, and industrial executive.

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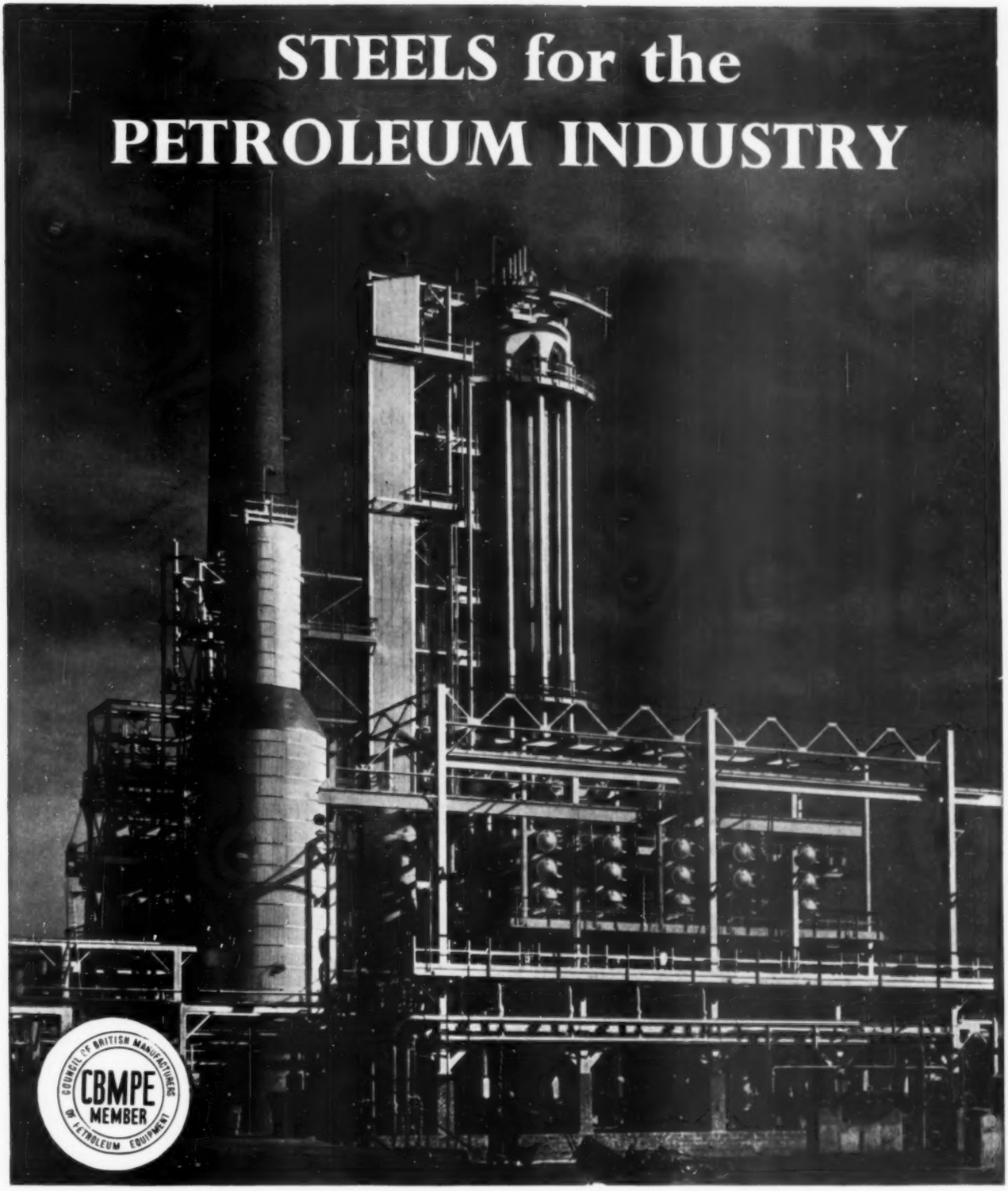

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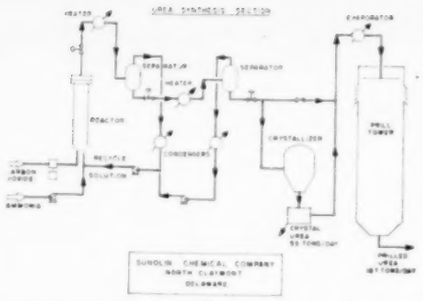
Sun-Olin Mathieson Urea Plant

Sun Oil Co. and Olin Mathieson Chemical Corp. have organized SunOlin Chemical Co. to build a 200 ton per day urea plant at North Claymont, Del. Completion of the $8 million plant is scheduled for early next spring. The M. W. Kellogg Co. is prime contractor.

The SunOlin plant will use the Montecatini process in which liquid ammonia and CO_2 gas are reacted at 2,800 psi and 370° F. to form ammonium carbamate which then decomposes to urea and water. The process is in commercial operation in Italy.

Raw material for the plant will consist of 9 million cubic feet of natural gas per day and 120 tons of ammonia. The natural gas will be reformed with steam to produce 150 t/d of CO_2 and 10 mmcf of hydrogen. The by-product hydrogen will be piped to the nearby ammonia plant and oil refinery operated by Sun Oil Co.

In the steam methane reformer a mixture of steam and natural gas is heated to about 1500° F. in the presence of a nickel catalyst. Effluent CO, CO_2 and H gases are cooled to 700° F. and passed over an iron oxide and chrome oxide catalyst to convert most of the CO to CO_2. The carbon dioxide is concentrated by absorption in a MEA solution for charging to the urea synthesis section.



Production of 200 t/d of urea is accomplished by compressing raw ammonia and carbon dioxide plus recycle stock to 2,800 psi. This is charged to a reactor where about 50% is converted to urea. By recycling an overall conversion of about 95% is anticipated.

Both prills and crystals of urea are to be manufactured.

James I. Harper of Sun Oil Co. is president of the Sun Olin Chemical Co. and S. S. Johnson of Olin Mathieson is vice president.

Dewey & Almy Rubber Plant

Dewey and Almy Chemical Division of W. R. Grace & Co. activated a new petrochemical plant at Owensboro, Ky., on June 29. The plant produces butadiene-styrene synthetic rubber, polyvinyl acetate polymers and copolymers. Total capacity is 20 million pounds per year.

Elected Cooper-Bessemer V.P.

Charles G. Cooper has been elected vice president and international director of The Cooper-Bessemer Corp. In addition he serves as president and a director of Cooper-Bessemer International Corp., Cooper-Bessemer of Canada, Ltd., and Cooper-Bessemer, S.A., a Swiss Co. with offices at The Hague, Netherlands.

C. G. Cooper

H. A. Cecsarini

European Manager Appointed

Harry A. Cecsarini has been made European manager of Cooper-Bessemer, S.A., a Swiss company incorporated in Chur, Switzerland, with offices at The Hague, Netherlands. The company was established in 1958 for the purpose of furthering world-wide application and sale of Cooper-Bessemer engines and compressors outside of the United States and Canada.

M. Carter

Heads McKee Sales

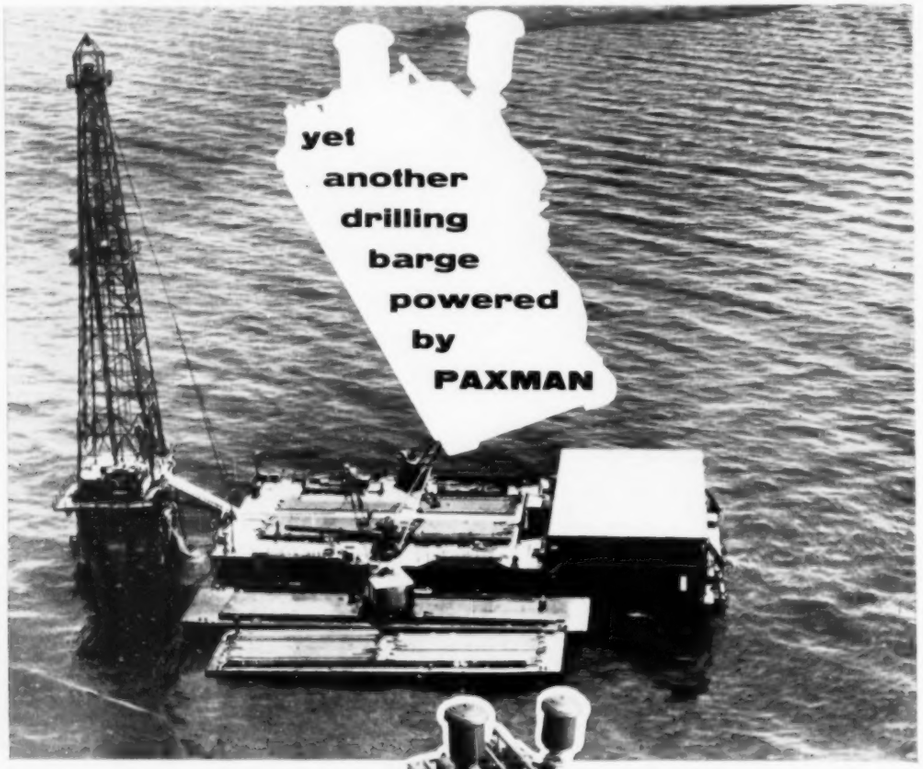
Macauley Carter has been appointed sales manager of the petroleum refinery division of Arthur G. McKee & Co. Prior to joining the McKee Co. in 1946 as a sales representative, Mr. Carter was treasurer of the Universal Oil Products Co., Chicago, Ill.

Hoechst HTP Process

The first plant for the production of acetylene and ethylene, using the Hoechst HTP Process, is now in an advanced stage of construction. These facilities are located at the main plant of Farbwerke Hoechst AG., Frankfurt-Hoechst, West Germany and will have a capacity of 100,000,000 pounds per year of acetylene plus ethylene.

Italy Aids Romanian Refinery

For construction of an oil refinery at Ploesti, negotiations are underway between the Romanian import company "Mazinoimport" and the Italian company "Ansaldo", Genoa, and the Fench company "ENSA", which belongs to the Schneider group. Both companies hope to supply equipment for the refinery.



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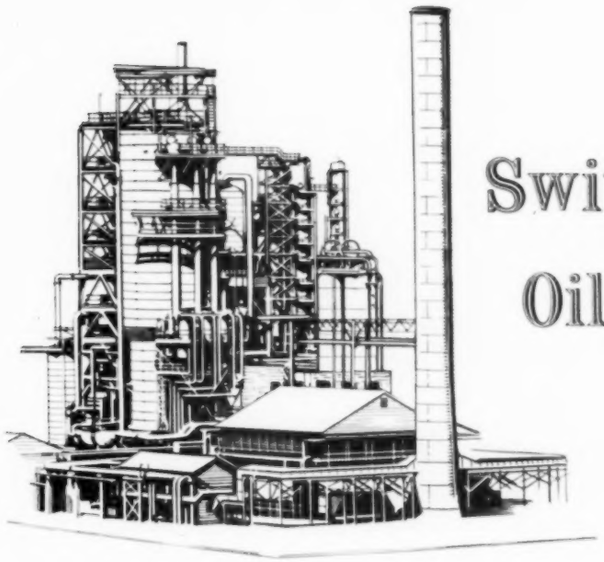

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- STANLOW, GEELONG,
- KWINANA, SARNIA,
- FRONTIGNAN, L'AVERA, SERIA,
- BOMBAY, VENICE, CARDON,
- MARACAIBO, HAMBURG,
- PERNIS, LAGOS, HAIFA,
- ADEN, IRAN, IRAQ,
- KUWAIT, BAHREIN, BURMA,
- CEYLON, and MALTA.

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Molecular Sieve Dehydration

Union Carbide International Co. has developed a method of dehydrating jet fuels with Molecular sieves. The synthetic zeolites are produced in the form of hard pellets about the size of a grain of rice. Jet fuel flowing through a bed of the material is reduced in water content to approximately zero ppm. Union Carbide believes that use of the zeolites will eliminate the danger of freezing and engine flameouts.

French Equipment To Romania

Under its 1959 trade agreement, Romania will deliver to France 130,000 tons of gasoline (same amount as in 1958), 120,000 tons of gas oil (plus 20,000 tons), 60,000 tons of sulfur-free fuel oil (minus 20,000 tons) and drilling equipment in the value of 250 million francs. In return, France is considering the export of refinery installations.

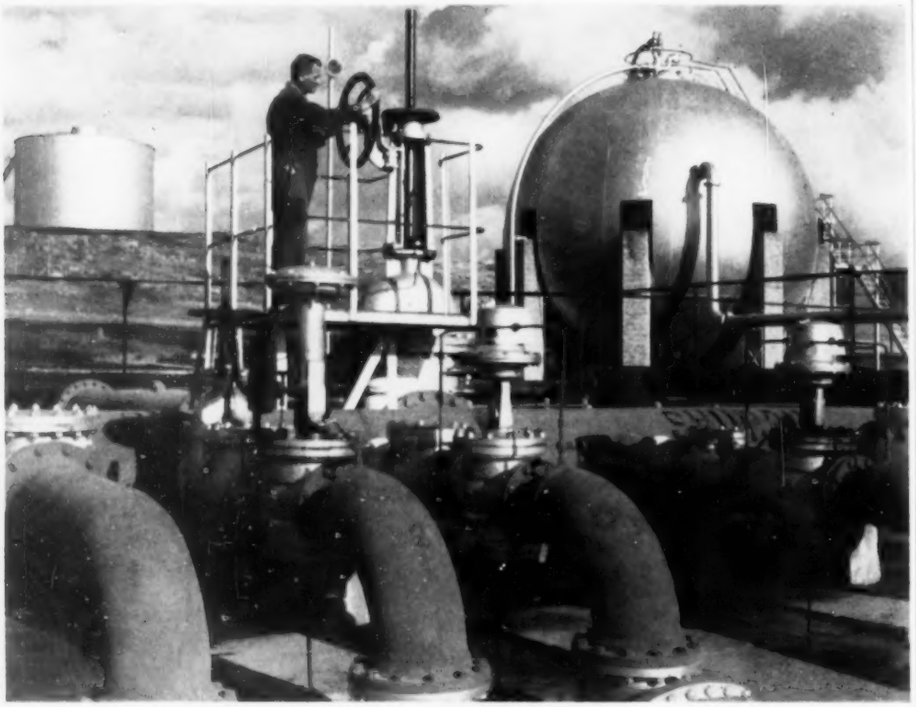
New Soviet Refineries

At least 12 big refineries are to be built in the Soviet Union during the next 7 years. Seven are to be located in the RSFSR, three in the Ukraine, one in Kazakhstan, and two or three in Byelorussia. The plant in Polotsk (Byelorussia) is to be one of the largest in Europe.

Japanese Petrochemical Plants

Tears Engineers, Dallas, and Iino Shipbuilding & Engineering Co. Tokyo, will collaborate in the design and construction of two Japanese petrochemical plants. A 125-ton ammonia plant for Nitto Chemical Industry Co. Ltd. will manufacture synthesis gas from fuel oil by the Texaco process. The same combination will design and supervise a major part of a $20 million butanol and octanol plant for Kyowa Fermentation Industry Co., Ltd., Ube, Japan. Charging stock will be naphtha.

CONTRACTORS TO THE OIL INDUSTRY



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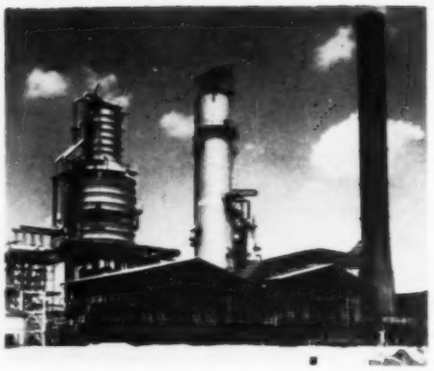


World's Largest Pipe Still

At Whiting, Ind., Standard Oil Co. (Indiana) starts operating the world's largest crude oil pipe still. Design capacity is 140,000 barrels a stream day. It will replace nine smaller, obsolete stills with their higher operating costs, and give the refinery more flexibility in manufacture of improved-quality, higher-octane gasolines. Three huge furnaces supply the heat needed to distill the 140,000 barrels of crude oil processed daily. A year's operations will use as much heat as required annually to heat 27,000 average homes in the Chicago area.

M. Worthington

E. W. Van Ness

New Parsons Executives

E. W. Van Ness and Mark Worthington have been elected vice presidents of The Ralph M. Parsons Co., engineers and constructors of Los Angeles. Mr. Van Ness is manager of the petroleum and chemical engineering division. Mr. Worthington, manager of cost engineering division, has full responsibility for all cost estimates, cost control, and other cost work.

Ffrench Joins Cooper-Bessemer

Leopold A. Ffrench has joined the Cooper-Bessemer International Corp. office at New York City and will devote his attention to the application and sale of engine-driven and motor-driven compresssors for oversea installation.

New UOP Department

Universal Oil Prodcuts Co. has formed a chemical products development department.

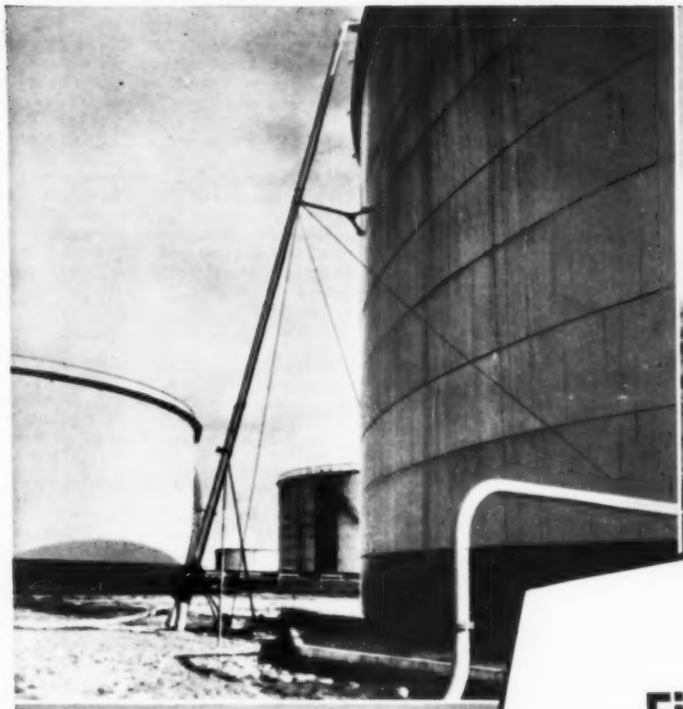
Management of new department is Richard J. Schoenenberger, formerly manager of UOP's McCook, Ill., manufacturing plant. He will be assisted by John C. Iverson and Frank Stolfa. Mr. Schoenenberger will report to Marcus R. Schrein, vice president of manufacturing.

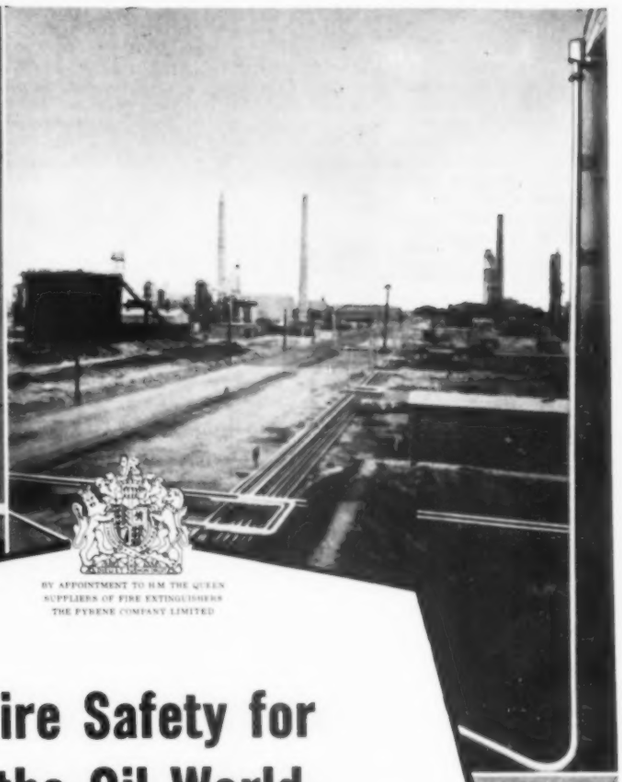
Houdry Appointment

Houdry Process Corp. has appointed Lindeteves-Jacoberg, N.V., of The Hague, Netherlands, as a Houdry representative in Benelux (Belgium, Netherlands, Luxembourg), the United Kingdom and the Union of South Africa.

New Tel Processes

A number of new processes for making tetraethyl lead are currently being studied by Ethyl Corp. Details on recent discoveries in the Ethyl laboratories, which potentially represent a major improvement over the present commercial process for making tetraethyl lead, are scheduled to be reported in the near future.





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Automation Tools

(Continued from page 96)

per wires. The receiver indicates or records the signal in terms of the actual value of the process variable, compares it with a pre-determined set-point, and sends the difference to the controller as an error signal. The controller then converts this into a corrective 4-20 milliampere output to operate the control valve—again transmitting over a single pair of copper wires.

All transmitters, receivers and controllers operate on a force-balance principle. The force balance circuit has four basic parts—a beam, detector, oscillator, and magnet unit. Input force deflects the pivoted beam. This changes the gap in the detector, which consists of two pieces of ferrite; one mounted on the beam, the other on the chassis. As the spacing between the two pieces of ferrite changes, there's a proportionate change in the inductance of the coil which is wrapped around the stationary portion of the detector. When this happens, the oscillator changes its output accordingly, between 4 and 20 milliamperes. This current is fed back to the magnet unit, producing a force on the beam that is equal and opposite to the input force, limiting full-scale beam motion to approximately one-thousandth of an inch.

The "Electrik Tel-O-Set" may be converted readily to cascade and ratio control without adding or changing parts. Transducers make the system compatible with pneumatic instruments.

Line Pneumatic Transmitter

Baily Meter Co. has introduced a force balance line flow transmitter which produces signals directly proportional to the flow. An integral part of the instrument is a Cosine square root extractor thus eliminating the need for external square root extracting devices where linear flow signals are required.

Pemex Expansion

Petroleos Mexicanos announced on May 11 that a contract was awarded to The Lummus Co., for approximately $21 million for expansion of Pemex's Salamanca refinery, and for a 220 tons per day anhydrous ammonia plant also at Salamanca.

Petro-Chem Appointment

John J. Griffin has been appointed chief engineer of Petro-Chem Development Co., Inc. He was formerly manager of the Service Department. Prior to joining Petro-Chem Development Co., Inc., he had served as Chief Engineer with National Airoil Burner Co. in Philadelphia. In his capacity as a process heating specialist he has visited refineries and petrochemical plants throughout the world.

New Zealand Refinery

A $45 million project, with 60% capital held by the Shell group and 40% by New Zealand investors will build and operate a refinery within three years of a site becoming available. The refinery will process imported "enriched crude", if suitable oil should later be found in New Zealand, this would be used. The refinery will supply more than 90% of New Zealand's petroleum requirements. Initial capacity would be two million tons a year (40,000 bbls day).

Mexican Cat Cracker

Lummus Co., of New York, has contributed a credit of $7,560,000 to build a catalytic cracking plant and an ammonia plant, part of a projected Pemex petrochemical project.

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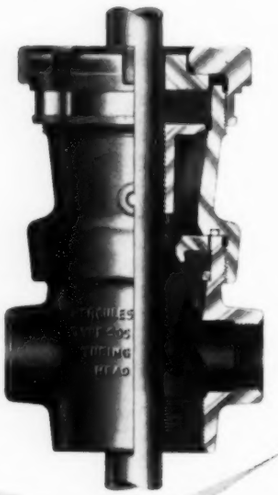
Hercules "Type SOS" is a 4000 pound test stripper tubing head. The lower section contains the neoprene tubing stripper; the upper section or bowl contains the slips and packing arrangement. The SOS is unsurpassed for use in well servicing operations in addition to its use in flowing wells.



HERCULES TYPE SO

TUBING HEAD

Hercules "Type SO" tubing head is actually the lower section of the "Type SOS" tubing head, containing the slips and packing arrangement. It is particularly suitable for pumping due to its compactness, being approximately 12 inches high.

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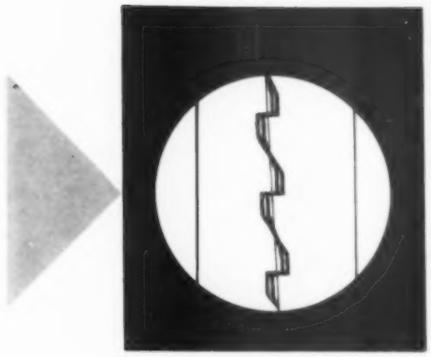

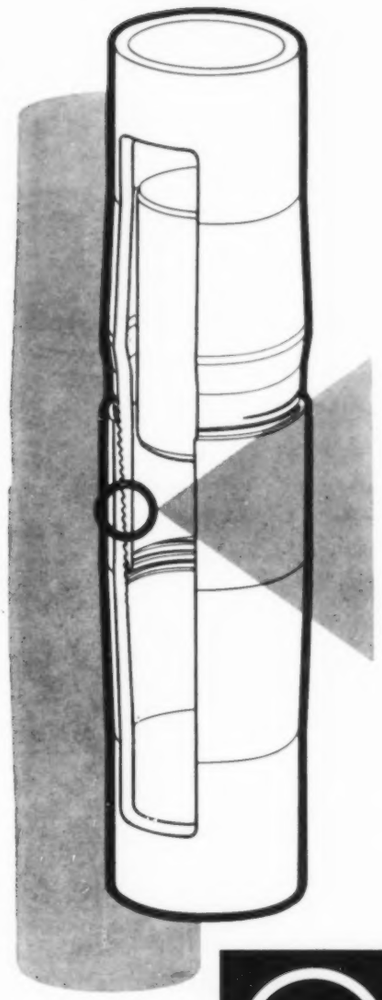

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Growth of Italian refining

by R. Pezzoli

ITALIAN refineries in 1958 processed 24,184,413 tons of crude, an increase of 16.30% over the 2,794,157 tons refined the preceding year. The total was composed of 22,836,579 tons of imported crude (19,625,372 in 1957); 1,327,663 tons of domestic crude (1,007,202); and 20,171 tons of residuals (91,583). Yields, according to the Ministry of Industry, are shown in Table I.

TABLE I—ITALIAN REFINERY YIELDS—1958

Products	Metric Tons	%
Premium gasoline	587,238	2.43
Regular gasoline	2,734,973	11.31
Jet fuel	716,218	2.96
Kerosine	477,572	1.97
Gas-diesel oil	4,670,173	19.31
Fuel oil, heavy	10,486,950	43.37
Fuel oil, fluid	1,356,430	5.61
Fuel oil, extra fluid	55,514	0.23
Lubricants	154,057	0.64
Bitumen	562,189	2.32
Petrochemical raw material	131,440	0.54
LPGas	486,097	2.01
Others	218,770	2.28
Losses	550,195	2.28
Refinery operations	996,607	4.12

The data in Table I emphasize the small yield of light products (i.e., gasoline and other distillates) in comparison with the large amount of black products. This balance probably will rise, because gasoline yield continues to diminish while fuel oils increase. The total production of regular and premium gasoline, now amounting to 13.74%, in the preceding year was equivalent to 14.81%. For the heavy products (i.e., fuel oils), the percentages climbed from 46.27% in 1957 to 49.21% in 1958.

Refineries in 1958 recorded exports of petroleum products totaling 9,483,388 tons against 6,204,305 in 1957. Exports by product in 1958 and 1957 (bunkers excluded) are shown in Table II.

TABLE II—ITALIAN EXPORTS

	1958 (Tons)	1957 (Tons)
Gasoline	1,512,808	1,360,097
Jet fuel	569,117	367,824
Kerosine	229,938	326,396
Gas-diesel oils	2,031,981	2,158,863
Fuel oil	3,002,379	1,886,465
Lubricants	17,046	7,992
Solvents	16,977	9,298
Paraffin	610	1,610
Bitumen	100,443	84,569
LPGas	2,009	1,191
Total	9,483,388	6,204,305

Foreign Bunkers: Foreign bunkers to ships and airplanes registered a substantial gain, except for jet fuel, as shown in Table III.

TABLE III—FOREIGN BUNKERING IN ITALY

	1958 (Tons)	1957 (Tons)
Jet fuel	14,517	16,412
Gas oil	225,206	170,068
Fuel oil	1,775,482	999,603
Lubricants	5,246	5,514
Total	2,020,451	1,191,237

Marketing: Italian consumption rose to 12,531,388 tons in 1958, compared with 11,430,000 tons in 1957. From recorded sales, domestic consumption of products was as shown in Table IV.

TABLE IV—ITALIAN PRODUCT CONSUMPTION

	Tons
Avgas	17,786
Motor gasoline	1,854,276
Kerosine	37,703
Kerosine for agriculture	120,574
Motor diesel oil	1,615,464
Diesel oil for agriculture	449,195
Bunker diesel oil	185,991
Fuel oil	7,538,662
Lubricants	183,200
Bitumen	478,033
Solvents	19,399
White oils	6,912
Insulating oils	11,621
Vaseline	199
Paraffin	12,373

Italy's Crude Imports: Italy imported 22,720,366 tons of crude in 1958, against 19,790,794 in 1957. Imports, by country in metric tons, are shown in Table V.

TABLE V—ITALIAN CRUDE IMPORTS

From:	1958 (Tons)	1957 (Tons)
Kuwait	7,440,114	4,996,331
Saudi Arabia	5,935,760	3,182,652
Iraq	4,685,179	3,350,077
Qatar	1,170,364	233,258
Egypt	1,129,534	236,021
USSR	1,051,149	618,403
Venezuela	730,996	1,016,681
Iran	496,845	564,180
British Borneo	80,425	—
USA	—	457,889
Mexico	—	121,531
Peru	—	13,771

Recapitulation: Italian refining activities in 1958, based on the foregoing data, were favorable as to quantity but not quality, because in that year exports amounted to a little less than 105 billion lire, against about 109 billion lire in 1957. In 1958, the volume of exports, viz., 3,279,000 tons, was higher than in the preceding year. However, the problem of prime importance to all interested circles in Italy may be summarized as follows: Fuel oil represents 48.8% of refinery yields. Domestic consumption of fuel oil exceeds that of gasoline and diesel oil, respectively, 4.3 times and 3.5 times; and exceeds total consumption of the major products (i.e., gasoline, diesel oil, and LPGas) 1.6 times. As for exports, fuel oil ranks first as to quantity.

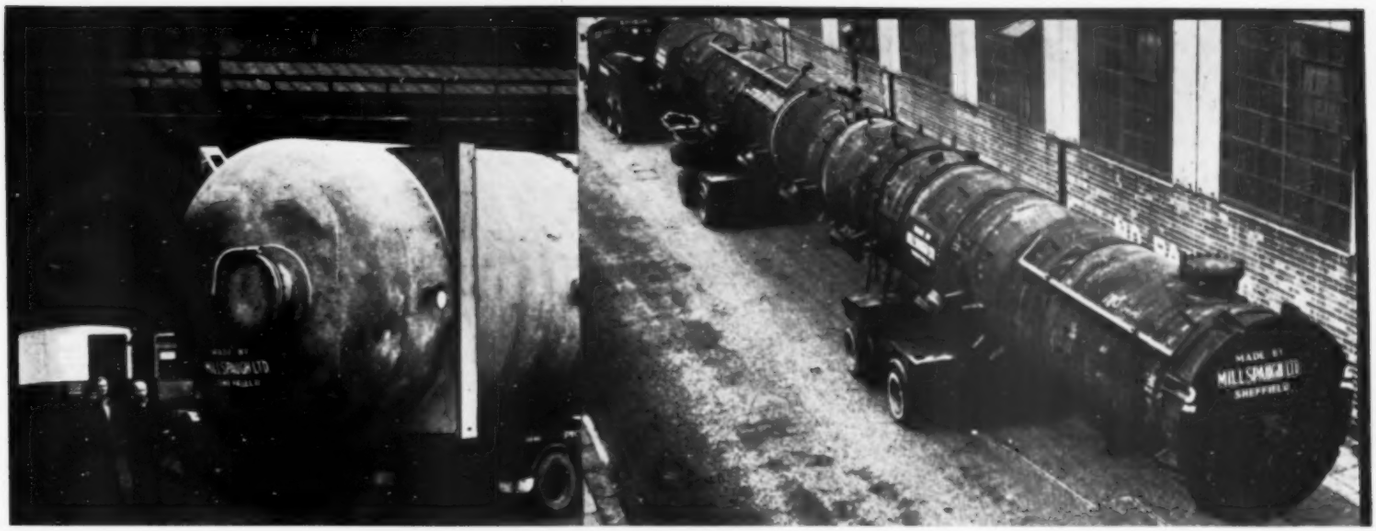
In the domestic market, fuel oil pays a production tax of 3,100 lire per ton ($5.00

TABLE VI—ITALIAN REFINERIES, DECEMBER 31, 1958

(Crude capacity in metric tons per year, including a 30% reserve required by law)

Name of Company	Plant Location	Permitted Capacity	Actual Capacity
Agip Mineraria (ENI)	Cortemaggiore (Piacenza)	130,000	130,000
API (Independent)	Falconara Marittima	1,300,000	1,300,000
Aquila (Cie. Franc. Petr.)	Trieste	900,000	1,350,000
Condor (Shell)	Rho (Milano)	1,820,000	2,000,000
Dellepiane (Ind.)	Genova-S. Quirico	78,000	78,000
DICA (Ind.)	Carrara	455,000	455,000
Esso Standard Italiana	Trieste-S. Saba	325,000	325,000
Garrone (Ind.)	Genova-S. Quirico	1,495,000	1,495,000
Getty Oil Italiana (J. P. Getty)	Gaeta	390,000	1,300,000
ICIP (OZO)	Mantova	552,000	552,000
ILSEA (Ind.)	Valmadrera (Como)	117,000	117,000
INPET (Shell)	La Spezia	1,500,000	2,000,000
IPLOM (Ind.)	Genova-Sarissola	208,000	208,000
IROM (ENI-British Petroleum)	Porto Marghera	1,800,000	1,800,000
ISLOM (Ind.)	Palermo	450,000 (Planned)	—
ITALIA (Ind.)	Cremona	520,000	1,300,000
Lombarda Petroli (Ind.)	Villasanta (Milano)	260,000	260,000
Mobil Oil Italiana (Socony Mobil)	Napoli	3,640,000	3,640,000
Nilo (Ind.)	Milano	201,500	201,500
Petrolidi Italia (Ind.)	Firenzuola-d'Arda (Firenze	208,000 221,000	208,000 Idle
Purfina Italiana (Petrofina)	(Genova (Milano (Roma	611,000 286,000 507,000	630,000 286,000 580,000
RA.SI.O.M. (Ind.)	Augusta	5,200,000	2,200,000
ROL (Ind.)	Viguzzolo (Alessandria)	65,000	65,000
Sanquirico (Ind.)	Genova-S. Quirico	195,000	221,000
SARN (ENI)	Novara	91,000	91,000[1]
SAROM (Ind.)	Ravenna	1,300,000	1,300,000
SARPOM (Fiat-Petrolcaltex)	Trecate (Novara)	1,300,000	1,300,000
SIROM (Ind.)	Cologno Monzese (Milano)	67,600	67,600
Mediterranea (Ind.)	Milazzo (Messina)	2,600,000 (Planned)	—
SPI (Ind.)	Fornovo Taro (Parma)	104,000	104,000
STANIC (Standard)	Bari	1,820,000	2,460,000
Jersey (ENI)	Livorno	1,950,000	2,600,000
STOI (ENI)	Firenze	455,000	800,000
Volpato (Ind.)	Milano	91,000	91,000
TOTAL		33,631,600	33,001,100

[1] Plant dismantled and reconstructed at Gela for processing Gela's heavy bituminous crude on a small scale. ENI in this area intends to build a large refinery and a big petrochemical plant.



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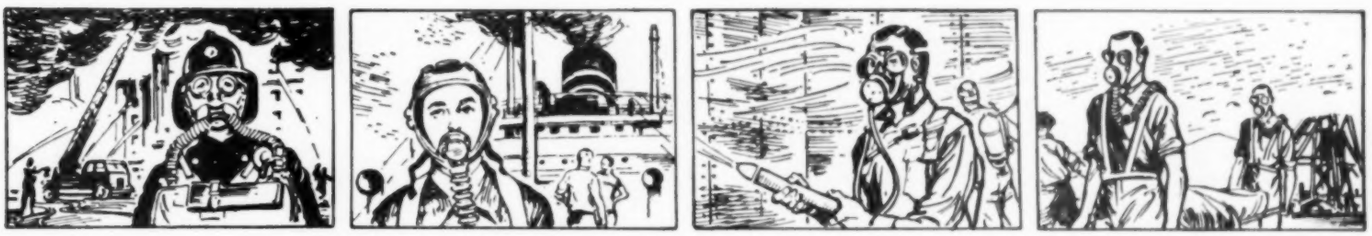

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per ton), and the general income tax amounts to 640 lire ($1.03). The fuel-oil tax exceeds that of competitive fuels. Coal pays 1,030 lire per ton; natural gas, 150 lire per cubic meter. In terms of 1,000 calories, the tax for the three competitive fuels is roughly: fuel oil, 0.55 lira; natural gas, 0.35 lira; coal, 0.20 lira.

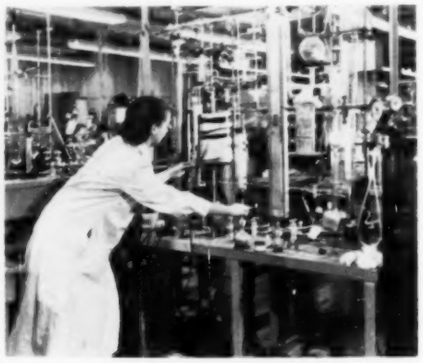
The production tax applies also to products used as fuel by the refinery, and is charged to working expenses.

Interest of the oil industry in this marketing trend is easily understood, and government administrators in the past have been concerned about how to meet demand. Paradoxically, refinery production considerably exceeds domestic consumption; but this is explained by the fact that this production represents yields from crude oil processed on behalf of foreign operators. Thus, to meet market demand, it has been necessary to import oil from other countries to keep within Italy part of the refinery production which previously had been intended for export.

As the accompanying list (Table VI) of Italian refineries shows, processing capacity assigned to each plant by concession decree (including the 30% of reserve required by law) has been surpassed.

At the present time, Italy's refineries, according to concession decrees, have a capacity of 27,581,600 metric tons, 30% included; but the actual processing capacity, calculated on the basis of tests or reliable estimates, amounts to 33,001,100 metric tons.

An expansion from 2.2 to 5.2 million tons yearly at RASIOM refinery at Augusta, and three new projects planned respectively for Palermo (ISLOM: 450,000 tons), for Milazzo (Mediterranea: 2,600,000 tons), and for Gela (ENI: not reported capacity) should make the total rise to about 38 million tons per year. END



High vacuum unit in the new Research and Development laboratory of Engelhard Industries, Inc. in Newark, N. J. measures the surface area of catalysts containing precious metals. The process, which involves nitrogen adsorption at liquid nitrogen temperature, helps to determine the efficiency of catalysts.

Catalyst Research Labs

Englehard Industries, Inc. opened its new research and development laboratories at Newark, N. J., at the time of the recent World Petroleum Congress meeting. As one of the world's largest refiners of precious metals the company has been active in the development of catalysts employing platinum.

In the catalysts preparation section at Newark the company is studying optimum compositions and methods of preparation. Studies of catalyst surface, porosity and distribution of pore size within the catalyst are in progress.

Process studies in the petroleum section are centering on methods of minimizing cracking in naphtha reforming and maximizing high octane component production. Individual reactions occurring in reforming are being investigated.

Englehard is devoting much attention to air pollution control. A major project is to perfect catalytic oxidation of unburnt fuel from gas and diesel engine exhaust. Applications to industrial fumes also are being developed.

The new laboratories are equipped with pilot plant units for process work and all modern analytical instruments to aid research workers in their activities.

Atlantic Wax Plant Completed

Construction of one of the world's largest MEK dewaxing-deoiling plants for the manufacture of paraffin waxes has just been completed by Badger Manufacturing Co., Cambridge, Massachusetts at Philadephia refinery of The Atlantic Refining Co. The plant has a rated capacity in excess of 216 million pounds per year of paraffin waxes of low oil content (some as low as 0.2%).

Basically, Texaco Development Corp.'s MEK (methyl ethyl ketone) solvent dewaxing process is employed. However, the detailed design and final engineering phases were unusually complex as the plant had to be capable of handling eight different feedstocks (light, medium and heavy waxy distillates from a vacuum pipe still) through 14 operations to produce a full line of refined and semi-refined paraffin waxes.

Oil Firms Set Merger

Pan-Israel Oil Co. and Israel-Mediterranean Petroleum stockholders have approved consolidation of the two companies into their wholly owned subsidiary, Magellan Petroleum Corp.

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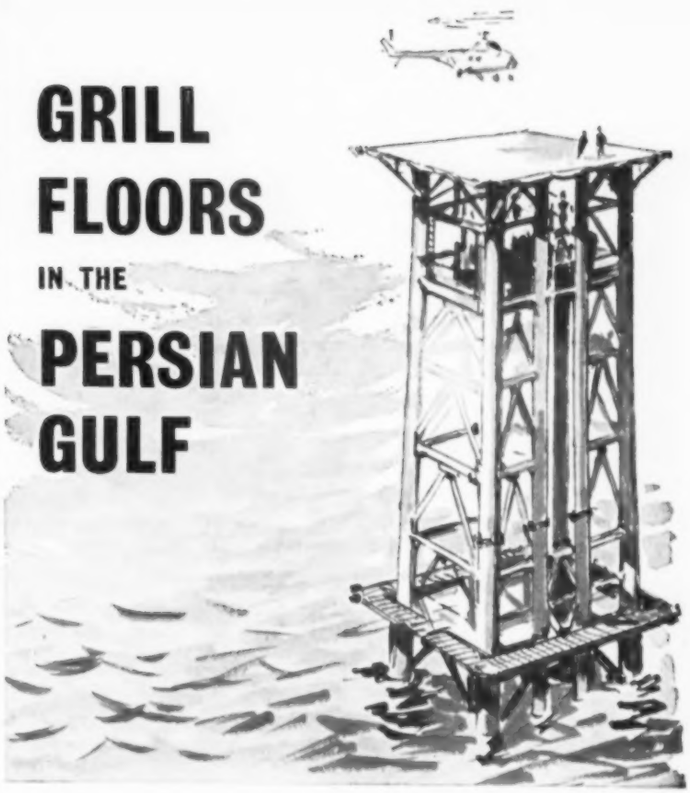

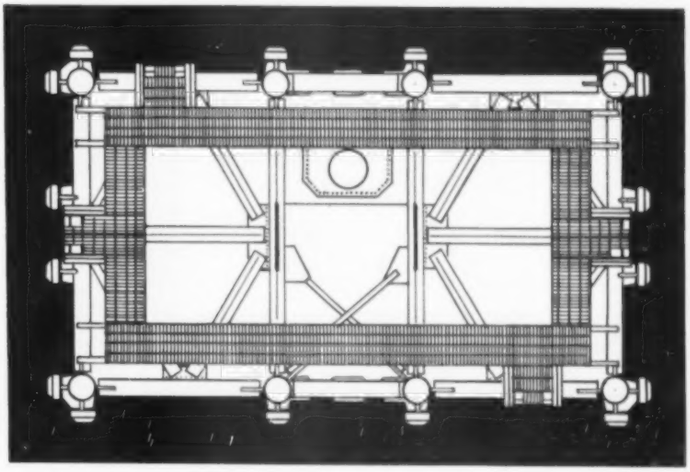

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OIL COMPANY STAFF CHANGES

PAUL SIECKE has been appointed general manager of the Cincinnati Refinery of Gulf Oil Corp., succeeding Thomas F. Hogan who is retiring. Latham J. Lashley succeeded Mr. Siecke as director—process design in the Pittsburgh office.

Mr. Siecke joined Gulf in 1933 at the Port Arthur, Texas, refinery. In 1950 he became assistant to the manager of the Engineering and Construction Department and in 1955 was named director of process design. Mr. Lashley was section head in the process design division prior to his appointment as Mr. Siecke's successor.

T. A. McIVER, formerly technologist, at Shell Oil Co. of Canada's Shellburn Refinery, has been appointed senior technologist, at Montreal East Refinery.

W. L. CULBERTSON has been promoted to manager of Phillips Petroleum Co.'s natural gasoline department to succeed G. W. McCullough who is now vice president, natural gasoline.

Mr. Culbertson joined Phillips in Oklahoma City in 1939. He has been assistant manager of the department since 1956.

FREDERIC H. HOLMES, vice president in charge of the research and technical department of Texaco Inc., has been named vice president in charge of the refining department to succeed John S. Worden, retired.

L. C. Kemp, Jr., vice president in charge of the petrochemical department (domestic), will succeed Mr. Holmes as vice president of the research and technical department.

William P. Gee, vice president in charge of the petrochemical department (foreign), will also be in charge of petrochemicals—domestic.

J. L. PORTER has been appointed to the newly-created position of petrochemical advisor to the manufacturing department of British American Oil Co. Ltd. His headquarters remain in Toronto.

He joined British American in 1934 and has served the company at its Montreal, Toronto, Calgary, Moose Jaw and Clarkson refineries. Since July, 1954, he has been head process engineer in the manufacturing department, head office.

JOHN K. McKINLEY has been appointed assistant to the vice president in charge of the research and technical department of Texaco Inc. Since October, 1957 he has been assistant director of research at the department's headquarters in Beacon, N.Y. He joined Texaco at Port Arthur, Texas, in 1941.

FRED POWELL has been elected president of California Chemical Co., Standard California subsidiary. W. H. Shiffler was named vice president. G. L. Parkhurst continues as chairman in addition to his other assignments with Standard. Mr. Powell will coordinate activities of Standard's two chemical subsidiaries, Oronite Chemical Co. and California-Spray-Chemical Corp.

MORRIS PREIDIKMAN has been appointed assistant process engineer in the technical division of Vickers Petroleum Co.

ROBERT D. BENT has been named general manager of manufacturing for Atlantic Refining Co. He had served as assistant general manager of the department since February of 1959. He succeeds W. F. Stroud, who has retired after nearly 43 years with Atlantic. Mr. Stroud had been a vice president and the general manager of manufacturing since 1952 and a director of the company since 1955. He will continue as a director.

Mr. Bent joined Atlantic's research and development department in 1935 and in 1953 was named director of the development division. In 1958 he was transferred to manufacturing as manager of the technical service department.

JOHN W. de GROOT, who helped form the Annual Pipe Line Conference of the American Petroleum Institute and served as its chairman for nine consecutive years, has retired as president of Tuscarora Pipe Line Co., Ltd. Mr. de Groot leaves active service after nearly 40 years in the Esso Standard Oil Co. organization, the last 19 as an executive of Tuscarora.

JAMES W. VICKERS, formerly vice president, marketing, has been elected executive vice president of The Vickers Petroleum Co., Inc.

James A. Doctor, formerly vice president, marketing, The Champlain Oil and Refining Co., Ft. Worth, Texas, had been elected vice president, marketing.

JAMES McDONALD has been named assistant general manager of Tidewater Oil Co.'s western division and Clifford A. Phillips has been named to succeed him as administrative manager of manufacturing. Both will make their office at the company's Los Angeles headquarters.

GLENN D. RUCKER has been appointed manufacturing superintendent of the Texas City, Tex., ethylene facilities of the Lion Oil Co. division, Monsanto Chemical Co. Mr. Rucker has been technical assistant to vice president J. B. Rogerson since 1957, and he replaces W. R. Nisbet.

THOMAS D. TIFFET

Thomas D. Tiffet, former chief engineer of Sinclair Refining Co., died May 17 at the age of 68. Mr. Tiffet, who retired in 1956, had been with the Sinclair organization since 1920, and was closely associated with the development of refinery processes used by the company.

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Synthetic Detergents Gain

Synthetics' share of the cleanser product market in the USA jumped to 72.2% in 1958 from 0.07% in 1935, according to Ralph Macon, market and development manager of The Atlantic Refining Co. He forecasts synthetics' proportion in 1959 will rise to 73.5%, and will rise gradually—to reach 80% of the market by 1965.

Plastic Bubble Caps

Wyatt's Plastics, Inc., Houston, is now producing bubble caps and risers from a thermosetting plastic material to meet corrosive resistance requirements of the oil refining and chemical processing activities. The company plans to extend its output to include trays, downcomers and all of the other assemblies for distillation and treating processes.

Follis Predicts Demand Up In 1959

R. G. Follis, chairman of Standard Oil Co. of California, said recently the business outlook is "becoming progressively more favorable," and forecast a growth in petroleum demand of 5% for the United States and 9% for the free foreign areas in 1959. Mr. Follis reported Standard is proceeding with a capital expenditure program in excess of $400 million compared with $343 million in 1958. Principal expenditures are for exploration and for development of already established oil fields, together with special outlays for refinery and tanker construction.

Fracture Simplifies Operation

A new simplified planning method for fracturing jobs is being made available to oil men by Halliburton Oil Well Cementing Co. The method begins with correlating all known reservoir data, past fracturing experience in the area, and desired production figure. This information is then used with a new technical publication, "A Method for Fracturing Treatment Design," which employs curves, charts, and formulas which enable the oil man to pick the fracturing treatment best for the particular well.

The specific information required includes effective permeability, core analysis, porosity, bottom-hole temperature and pressure, bottom-hole fiscosity of fluid, gas-oil ratio, and water production. In most cases, this information is available or can be obtained from reliable sources such as drill-stem tests, electric logs, laboratory tests, and the like.

This method also relies heavily on past experience in addition to a theoretical approach. All the information is "fed into" and worked through the publication to obtain possible treatment. Sometimes several alternate treatments can be found.

Sinclair Net to Rise

Capital expenditures of Sinclair Oil Corp. and subsidiaries for 1959 are expected to approximate $135 million, up $4 million from 1958 levels, according to P. C. Spencer. chairman and chief executive officer.

Capital expenditures for exploration and production of crude oil will probably account for $87 million, or 60% of the corporation's total 1959 budget. Noting the company's strong cash position, Mr. Spencer said, "we have no plans at this time for borrowing additional funds." He also ventured the opinion, based on increased earnings reported for the first quarter, that "the corner has been turned." but, as to an earnings forecast "price is the all-important factor in this huge-volume slender-profit business," he said.

Spherical Kaolin Catalyst

Kao-Spheres, a new spherical Houdry mineral Kaolin cracking catalyst, designed to decrease catalyst use and reduce equipment maintenance costs, has been developed by Houdry Process Corp. The spherical form reduces catalyst chipping and loss in fines. The Kao-Spheres do not have sharp edges which might cause equipment erosion.

Principles of Geochemistry

Principles of Geochemistry, by Brian Mason, summarizes the significant facts and ideas concerning the chemistry of the earth.

Chapters deal with the earth as a planet, distribution of the elements, and theories about the earth's pregeological history. Describes the materials and processes at and near the surface of the earth, the geochemistry of igneous, sedimentary, and metamorphic rocks, and the hydrosphere, atmosphere, and biosphere. The final chapter is a brief summary in terms of the geochemical cycle.

Brian Mason performed research work in geochemistry in Oslo and Stockholm. He received his Ph.D. in geology from the University of Stockholm in 1943. In addition to his present position as curator of physical geology and mineralogy at the American Museum of Natural History, Dr. Mason is also professor of mineralogy at Columbia University.

Oil Study Of Europe

Energie et Marche Commun—Elements Statistiques: A study of energy in the common market, the objective of which is given as the unification of scattered information on this subject. Covers the period 1950 through 1957, and contains much excellent information, including one section on petroleum alone which covers all industry activity including exploration—although the latter is only reviewed by maps showing discoveries, etc. Published by the Comite Professionnel du Petrole at 51, Boulevard de Coucelles, Paris (8), France. Distributed free.

ASTM Plastics Standard

COMPILATION OF ASTM STANDARDS ON PLASTICS, revised and up to date, has been published by Am. Socy. for Testing Materials, 1916 Race St., Philadelphia 3, Pa.; 1,108 pages, paper-covered; $8.00. New edition contains 43 standards not appearing in previous 1957 edition; compiled by Committee D-20 on Plastics.

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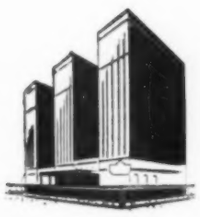

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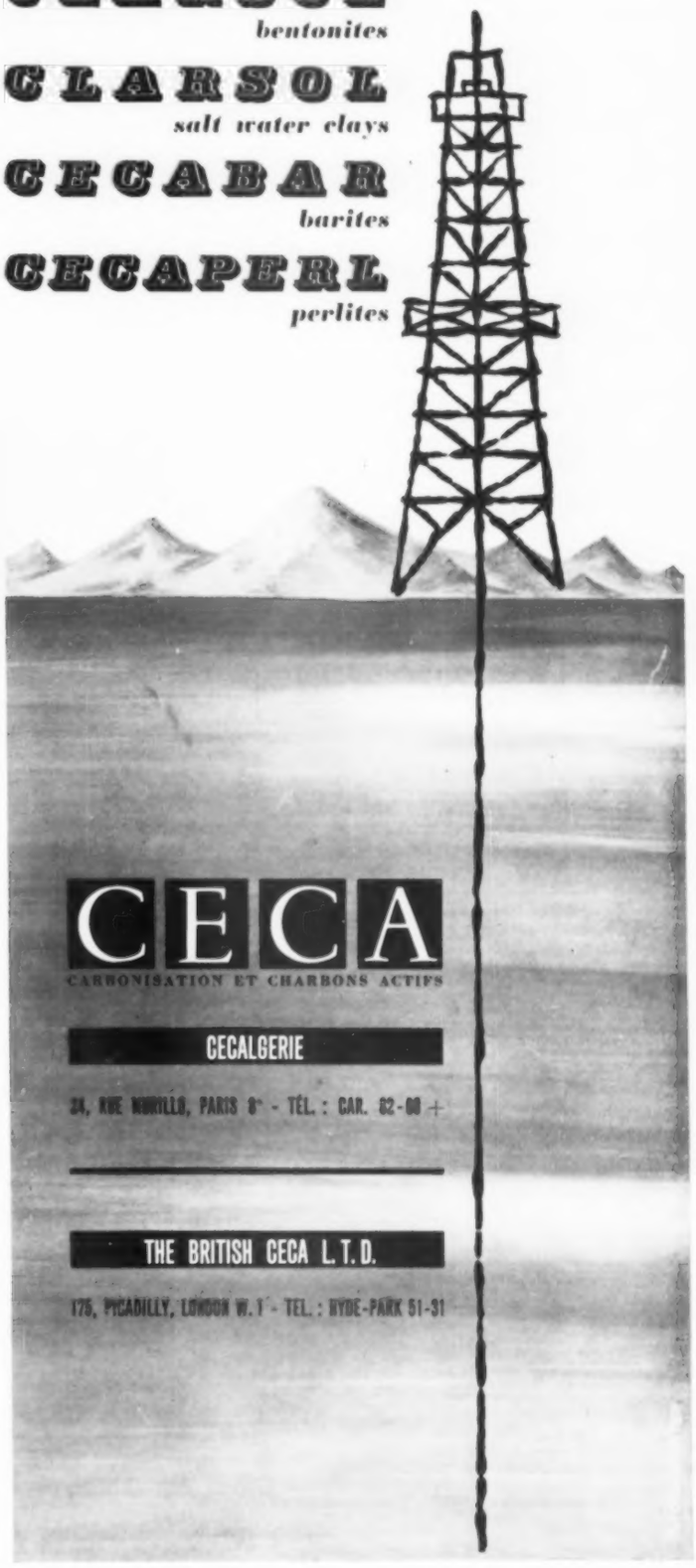

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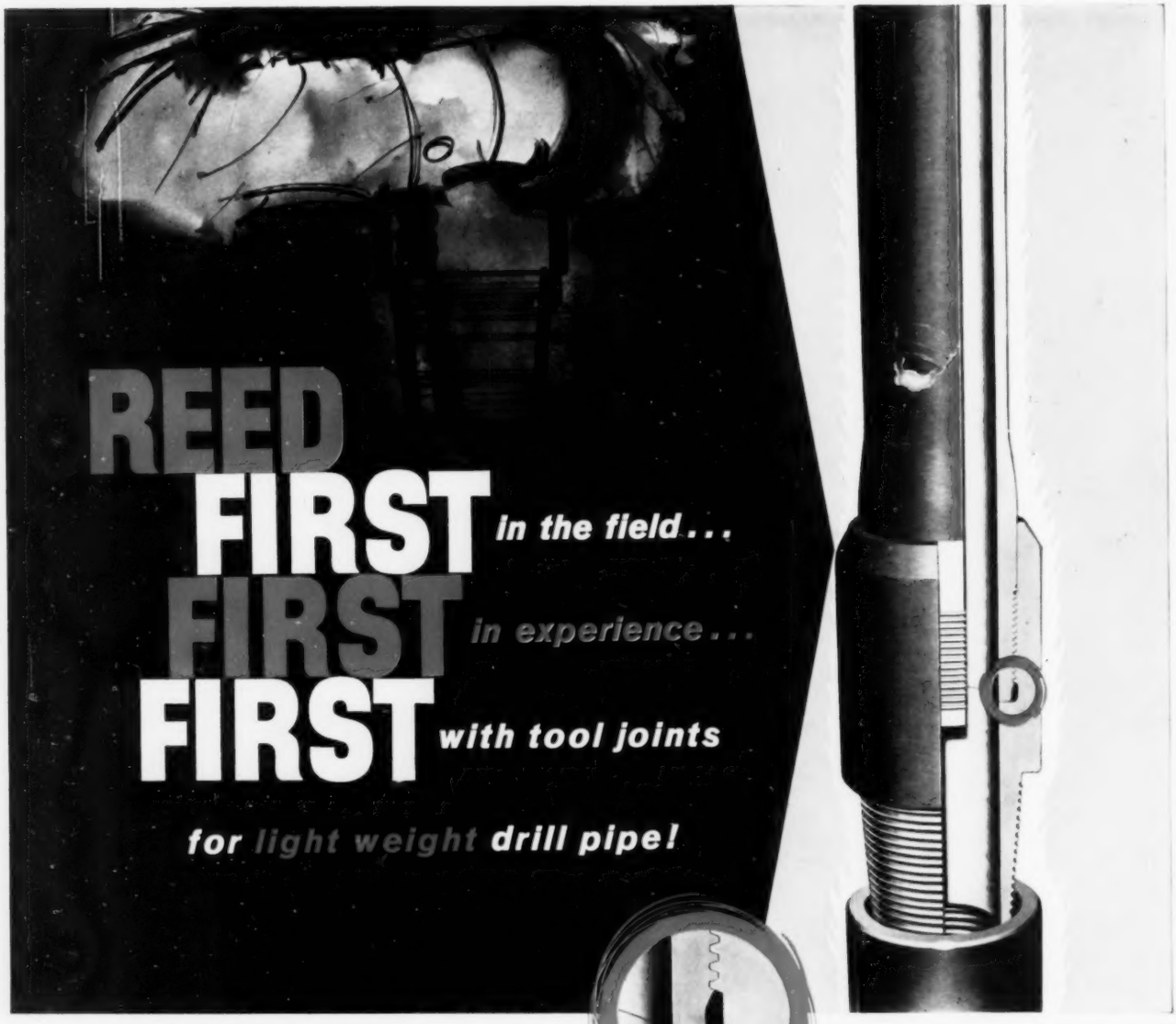

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